Construction Monitoring Annual Report 1

NEWCASTLE INNER CITY BYPASS - RANKIN PARK TO JESMOND

Report 1

6 March 2023 – 5 March 2024

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ACKNOWLEDGMENT OF COUNTRY

Fulton Hogan acknowledges the Awabakal People as the Traditional Owners of the land we are working on, and pay our respect to their Elders past, present and emerging.

We recognise their deep connection to Country and value the contribution to caring for, and managing the land and water.

We are committed to pursuing genuine and lasting partnerships with Traditional Owners to understand their culture and connections to Country.

Artwork by Luke Penrith, from Fulton Hogan's Reconciliation Action Plan.

Luke Penrith is a modern contemporary Aboriginal Artist living in Brungle NSW, Wiradjuri Country, His ancestry is connected through the Wiradjuri, Wotjobaluk, the Yuin and the Gumbaynggirr Nation.

Document control

This is an e-copy of the Plan and it interfaces with the other associated plans, which together describe the proposed overall project management system for the project.

The latest revision of this plan is available on the Fulton Hogan server. If any unsigned hard copies of this document are printed, they are valid only on the day of printing.

The revision number is included at the bottom of each page. When revisions occur, the entire document will be issued with the revision number updated accordingly for each owner of a controlled copy.

Attachments/Appendices to this plan are revised independently of this plan.

Revision History

REV	DATE	[redacted]	BRIEF DESCRIPTION OF CHANGE
0	27/08/2024		6 March 2023 – 5 March 2024 construction monitoring report 1
1	20/09/2024		Updated with Transport comments
2			

Contents

Tables

Figures

1 Introduction

This Construction Monitoring Report (CMR) outlines the annual construction monitoring programs results for the Newcastle Inner City Bypass - Rankin Park to Jesmond (RP2J) project. This plan is specific to the requirements set out in each construction monitoring program required by Conditions of Approval (CoA) C15.

In accordance with Infrastructure Approval (SSI 6888) CoA C9, the Rankin Park to Jesmond bypass project is implementing a range of environmental monitoring programs as set out within the framework of the Construction Environmental Management Plan (CEMP) and monitoring programs contained within the associated sub-plans as detailed below:

- Surface and Ground Water Quality Monitoring Program - CEMP Appendix B3 (SWMP Rev 5)
- Air Quality Monitoring Program - CEMP Appendix B5 (AQMP Rev 5)
- Noise and Vibration Monitoring Program - CEMP Appendix B2 (NVMP Rev 8)
- Flora and Fauna Monitoring Program - CEMP Appendix B1 (FFMP Rev 6).

Consistent with CoA C15, the Construction Monitoring Programs (CMP's) for Noise and Vibration has been incorporated into the respective sub-plan to guide all environmental monitoring and document the findings. The Surface and Ground Water Quality Construction Monitoring Program (SGWQCMP), Flora and Fauna Monitoring Program and the Air Quality Monitoring Program have been developed as standalone monitoring programs. The results of these monitoring activities are to be used in establishing trends and drive improvements, where necessary. The Secretary of the NSW Department of Planning, Housing, and Infrastructure (then DP&E now DPHI), approved the CEMP and associated sub-plans on 2 March 2023. The CEMP and relevant sub-plans have been updated and revised since the original approval. The Surface and Ground Water Quality Monitoring Program, Air Quality Monitoring Program and the Flora and Fauna Monitoring Program were approved by DPIE in June 2022. The Noise and Vibration Monitoring Program was included in the Noise and Vibration Management sub-plan and thus approved on 2 March 2023.

The results of the construction monitoring described herein for reporting period #1 (5 March 2023 – 6 March 2024) are to be provided to the Secretary, relevant agencies and Councils for information in compliance with CoA C15.

1.1 Purpose

The purpose of this plan is to meet the CoA C15 and describe how surface water, groundwater, air quality, noise and vibration and flora and fauna compares to baseline data and if additional mitigation or monitoring is required.

Key objectives for this report include:

- Data summary tables from monitoring undertaken in reporting period.
- Management responses to any exceedances which may have occurred during the reporting period.

This annual report has been prepared to provide a summary of surface water, ground water, air quality, noise, vibration, flora and fauna undertaken for the reporting period (6 March 2023 to 5 March 2024) and to assess the effectiveness of mitigation measures applied during construction works.

2 Environmental Monitoring

This section includes the results of the noise and vibration and air quality monitoring results and a summary of surface and groundwater quality and flora and fauna annual reports. Construction monitoring location maps can be found in Annexure A.

2.1 Surface and ground water quality

The surface water and groundwater monitoring report presents the findings of surface water quality and groundwater quality assessments for the reporting period, including February 2023 pre-construction.

The purpose of the SGWQCMP is to meet the CoA and describe how the Project proposes to monitor the extent and nature of potential impacts to surface water quality, groundwater quality and groundwater elevation during construction of the Project. The SGWQCMP will be implemented to monitor the effectiveness of mitigation measures applied during the construction phase of the Project and provide performance criteria which will be used to identify potential impacts.

This SGWQCMP is informed by the baseline studies developed for the Project EIS (GHD, 2016), continued baseline monitoring reports (Aurecon, 2021) and surface water quality data collected by Transport for NSW (Transport). Details of the surface and groundwater monitoring network, frequency of monitoring, and test parameters are provided in this report.

Reporting requirements associated with the Monitoring Program for the construction phase of the Project are presented in Table 2-1.

Table 2-1 Surface and groundwater quality monitoring requirements

Sampling Location	Frequency	Where addressed
Surface water sampling	Monthly and wet weather[1]	Section 2.1.1 of this report and Appendix B
Sediment basin sampling	Prior to discharge as per the Project EPL	Refer to Section 2.1.4 of this report
Groundwater data loggers and elevation	Quarterly	Section 2.1.3.2 of this report and Appendix B
Groundwater sampling	Quarterly	Section 2.1.3.1 of this report and Appendix B
Groundwater sampling post significant spill event	Should a significant spill incident occur, additional groundwater wells would be considered to be installed at that juncture if significant risks to groundwater quality were identified (which would likely trigger additional surface water monitoring locations).	N/A – considered as not required

1 Following 25 mm of continuous rainfall within a 24-hour period

Monthly surface water monitoring and quarterly groundwater monitoring is required to assess potential impacts from construction activities as outlined in the Environmental Impact Statement (EIS), (GHD, 2016) and the Submissions and Preferred Infrastructure Report (SPIR) (GHD, 2018). This monitoring program has been prepared based on the recommendations of the aforementioned reports to address the requirements of the Ministers Infrastructure Approvals (SSI 6888), applicable guidance and legislation.

Eleven metals, NTU, TSS, pH, nitrogen and phosphate was sampled for each groundwater and surface water monitoring location.

A summary of the annual surface and groundwater monitoring report is provided in the following section and the full report is included in Appendix B.

2.1.1 Surface water

The surface water monitoring was required to commence one month prior to construction commencing in February 2023. Surface water monitoring commenced in February 2023 and is included in this monitoring report. Therefore 13 months of monitoring is included in this monitoring report to include pre-construction monitoring data.

Ten surface water monitoring locations are required to be sampled monthly and when >25mm of rain in 24 hours is received. The >25mm rain event in 24 hours is required once per month when a rain event exceeds 25mm in 24 hours. The Project has two weather stations, they are located at the Jesmond compound and at 136 Lookout Road, located within site to track meteorological conditions.

In the reporting period, 18 monitoring events were completed, 13 being monthly and five surface water sampling events >25mm in 24 hours were undertaken.

2.1.1.1 Trends

Aluminium

Concentrations were reported above the ANZG (2018) criteria in groundwater and surface water and were predominantly within the range of preconstruction baseline data. Aluminium concentrations in surface water fluctuated, with higher concentrations correlating with periods of higher rainfall.

Arsenic

Concentrations were reported slightly above preconstruction results at several surface water monitoring locations. Concentrations above preconstruction baseline data were minor and are likely due to natural fluctuations.

Boron

No pre-construction baseline monitoring was undertaken for boron. Baseline data has been obtained from the February 2023 monitoring event, which occurred prior to land clearing works at the site. As such, the full range of pre-construction boron concentrations is unknown and should be used as an indicative guide only. Boron concentrations reported above the ANZG (2018) criteria were reported at WC Ironbark Ck-DS and are strongly correlated with elevated electrical conductivity, indicating the presence of brackish or saline waters. These results are therefore not considered attributed to site operations.

Cadmium

Concentrations of cadmium reported above the ANZG (2018) criteria and pre-construction baseline data were minor and are likely due to natural fluctuations and are attributable to the urban setting of the site.

Chromium

No exceedances were reported during the reporting period.

Copper

Concentrations of copper were reported above the ANZG (2018) criteria at all surface water. Concentrations were generally consistent with pre-construction results during the reporting period. Exceedances of the pre-construction baseline data were minor and are likely due to natural fluctuations.

Iron

Concentrations of iron were reported above preconstruction baseline data at several surface water monitoring locations. Increased iron concentrations appeared to decrease during high rainfall periods and may be reflective of the urban setting of the site or leaching of iron from exposed soils.

Lead

Concentrations of lead were reported above the ANZG (2018) criteria at WC 3-2 DS. Exceedances of the pre-construction baseline data were minor, and all lead results were stable and were below the laboratory LOR during most sampling events at all sampling locations.

Manganese

Concentrations of manganese were reported above the pre-construction baseline data at several surface water monitoring locations. Similar to iron, higher manganese results appeared to correlate with sampling during high rainfall periods and may be reflective of the urban setting of the site or leaching of manganese from exposed soils.

Nickel

Concentrations of nickel were predominantly reported above pre-construction baseline data at WC 3-2 DS. Exceedances of the pre-construction baseline data were minor and are likely due to natural fluctuations and are attributable to the urban setting of the site. Except for one occurrence at WC 4-2-DS which exceeded ANZG (2018) criteria.

Zinc

Concentrations of zinc were generally stable during the reporting period. Exceedances of the preconstruction baseline data were minor, with the majority of exceedances occurring during periods of high rainfall. Elevated concentrations of zinc are likely due to natural fluctuations and are attributable to the urban setting of the site.

Total Nitrogen

Concentrations of nitrogen were variable during the reporting period. Given the site is in an urban setting, nitrogen concentrations would be anticipated to fluctuate significantly with nutrient laden stormwater runoff from urban environments. It is therefore possible that detected elevated nutrient concentrations are reflective of the wider environment.

Phosphate (as P) (Total Phosphorus)

Concentrations of phosphorus were variable during the reporting period. Given the site setting in a heavily disturbed urban environment, phosphorus concentrations would be anticipated to fluctuate significantly with nutrient-laden stormwater runoff from urban environments.

TSS

TSS concentrations reported during the reporting period were highly variable and were likely influenced by conditions within creek lines. Creek lines in the study area were predominantly ephemeral or low flowing, which contributed to the build-up of debris within the creek lines, increasing TSS levels of the creek lines and likely impacting on the reported results. This is evidenced by the increase in TSS following high rainfall events, with settled debris likely flushed out of the creek lines during rainfall.

pH

Concentrations of pH obtained indicate that the pH reported outside of the acceptable criteria range during monitoring events could have been influenced by local conditions within the creek lines and was unlikely to be the result of acidic or alkaline water discharged from the site.

Turbidity

Turbidity concentrations reported during the reporting period were highly variable and were likely influenced by conditions within creek lines. Creek lines in the study were predominantly ephemeral or low flowing, which contributed to the build-up of debris within the creek lines, increasing turbidity levels of the creek lines and likely impacting on the reported results. This is evidenced by the increase in turbidity following high rainfall events, with settled debris likely flushed out of the creek lines during rainfall.

2.1.2 Surface water field sample exceedance investigation

When Kleinfelder attended the site to complete field sample monitoring, when there was an exceedance of pH and NTU they would report the exceedance to Fulton Hogan. Fulton Hogan would then go and investigate each exceedance to ensure the correct mitigations were put in place if required.

A summary of the exceedances is listed in Table 2-2. Exceedances within or downstream of the project during construction are highlighted in orange. Some exceedances are upstream of the project or before construction commenced and have not been highlighted as an exceedance.

Table 2-2 Surface water exceedance investigation

Monitoring	Date	Sample Location	NTU >50	pH (<6 - >8)	Colour	Investigation
Monthly	24/02/2023	WC 3-2 DS	383	6.07	Light brown	Pre-construction monitoring, was not contributed by construction.
		WC 5-1-DS	10.28	5.95	Clear	
Monthly	28/03/2023	WC 1-1 US	86.67	7.3	Light brown	Upstream of the project boundary. Was not attributable to site works.
		WC 1-3 DS	1473.17	7.24	Milky brown/white	FH completed an upstream NTU sample in Jesmond Park and was above field sampling meter scales >1000.
		WC 3-2 DS	1005.6	5.75	Brown	High NTU water coming from upstream and not contributed from the project. No clearing works had commenced in the vicinity of this sampling point. The project was not contributing to the NTU exceedances and low pH.
		WC 4-1 US	50.85	6.39	Light brown	Water upstream of project boundary. No clearing occurring in this area at this monitoring event. Not attributable to site works.
		WC 5-1-DS	96.73	6.22	Light brown	Lab sample TSS <23. No rain or groundwater present. Feb results 5.96, prior to construction commencing. Pre-construction water slightly acidic. Consistent with pre-construction monitoring results
		WC Ironbark Ck-DS	59.97	6.85	Cloudy white	. The closest monitoring point at WC 1-3DS, had a significant exceedance which was contributed by upstream of the project and could have contributed to the exceedance at this monitoring point.

Monitoring	Date	Sample Location	NTU >50	pH (<6 - >8)	Colour	Investigation
Monthly	21/04/2023	WC 1-3 DS	192.6	7.85	Light brown	Site water was not from the RP2J site. Ongoing dirty water coming from upstream.
		WC 3-2 DS	712	5.9	Cloudy grey/brown	High NTU water was not from the RP2J site. It was from upstream. Clearing had not commenced in this area yet in April.
		WC 5-1-DS	20.8	6.49	Clear	Pre-construction water slightly acidic. Consistent with pre-construction monitoring results
		WC Ironbark Ck-DS	132.45	6.85	Brown	22mm rain received on 20/4. The whole catchment would contribute to this exceedance. Closest upstream monitoring point could have contributed to this exceedance. Water at WC 3-2 DS was from water coming into the site upstream and not from the RP2J site.
Monthly & >25mm in 24 hours from 17/5	19/05/2023	WC 1-1 US	80.71	7.38	Light brown	Upstream of site, water not from the project.
		WC 3-2 DS	656.5	6.64	Light brown	Basin 8900W constructed. Received 42mm of rain in 5 days. Basin overtopping. High NTU water from upstream of the project flowing into the sampling point.
		WC 4-2 DS	46.13	6.86	Cloudy light brown	Basins overtopping from receiving 42mm of rain in 5 days.
		WC 5-1-DS	18.58	6.26	Clear	Pre-construction slightly acidic water. Natural low pH. Consistent with pre-construction data
Monthly	30/06/2023	WC 5-1-DS	-6.48	6.23	Clear	Lab sample <5 TSS. pH slightly low, Natural low pH. Consistent with pre-construction data. Water not flowing from site.
Monthly	26/07/2023	WC 4-3-US	17.8	5.73	Clear	Sampling location upstream of construction works. Project did not contribute to low pH water.
		WC 5-1-DS	4	6.15	Clear	Pre-construction water slightly acidic. Consistent with pre-construction monitoring results.
>25mm in 24 hours	8/08/2023	WC 4-2 DS	56.43	6.65	Light brown	38.6mm of rain received. Basins overtopping contributing to NTU exceedance.
		WC 4-3-US	2.3	6.25	Clear	Upstream of project. Project is not contributing to low pH.
		WC 5-1-DS	6.15	5.73	Clear	Consistent with pre-construction low pH results. Natural low pH in monitoring location.
Monthly	25/08/2023	WC 1-3 DS	9.7	8.74	Slightly cloudy brown	An upstream location undertaking a lot of concrete works. Upstream of the project was pH 9.
		WC 5-1-DS	24	6.27	Clear	Consistent with pre-construction low pH results. Natural low pH is in monitoring location.

Monitoring	Date	Sample Location	NTU >50	pH (<6 - >8)	Colour	Investigation
Monthly	28/09/2023	WC 1-1 US	106	7.13	Clear	Upstream to site. No construction impacts on upstream water.
		WC 4-1 US	7	6.29	Clear	Upstream to site. No construction impacts on upstream water.
		WC 4-2 DS	241	6.75	Clear	Unexpected 17.8mm of rain at 6am. In the middle of placing headwalls and scour protection. Controls installed to stabilise flow path as per approved PESCP.
Monthly	25/10/2023	WC 1-1 US	76.9	6.6	Clear	Sampling location is upstream of construction site. Construction site has not contributed to exceedance upstream.
		WC 1-3 DS	52.9	6.6	Clear	Upstream exceedance occurred at WC 1-1 US. NTU has decreased from upstream of the project to downstream. Water coming from upstream project.
		WC 4-1 US	900	6.8	Clear	Sampling location is upstream of construction site. Construction site has not contributed to exceedance upstream.
		WC 4-2 DS	345	6.1	Clear	Upstream water entered the construction site as 900NTU. As it got to the other side of the project, water had significantly dropped NTU. Low pH was from upstream water.
>25mm in 24 hours	27/10/2023	WC Blue Wren Ck-DS	83.4	5.9	Light brown	Basins in the southern interchange were overtopping after 43mm of rain and could have contributed to high NTU. High rainfall in an urban area would likely contribute to higher turbidity further downstream from site. Low pH is consistent with background data at this location down stream of Fill 1.
>25mm in 24 hours	6/11/2023	WC 1-1 US	99	7.6	Light brown	Sediment load in creeks due to basins overtopping after receiving 99mm of rain on 5/11. WC 3-2 DS had an upstream project basin overtopping into the creek line.
		WC 1-3 DS	110	7.7	Clear	
		WC 3-2 DS	484	5.2	Brown	
		WC 4-1 US	48.9	7.1	Light brown	
		WC 4-2 DS	114	6.9	Brown	
		WC Blue Wren Ck-DS	97	7.4	Light brown	
		WC Ironbark Ck-DS	139	7.3	Brown	
Monthly	16/11/2023	WC 1-3 DS	7.6	9.91	Brown	FH undertook upstream sampling of works, upstream was 9.3 pH. Not contributed by the project works. WC 1-3 DS was less than 1 pH unit above upstream sample location, resulting in a minor exceedance.

Monitoring	Date	Sample Location	NTU >50	pH (<6 - >8)	Colour	Investigation
		WC 3-2 DS	212	5.29	Greeny brown	SB8900W was being dewatered with compliant monitoring results and an upstream project started a discharge.
Monthly	18/12/2023	WC 1-3 DS	8.7	8.93	Clear	Fulton Hogan (FH) undertook sampling of upstream works and the pH was 8.5, the Dark Creek culvert was 8.9 pH, downstream was 8.9 pH, no sheen/odour. High pH water was observed from upstream, there is a less than 1 pH unit difference, resulting in a minor exceedance.
		WC 4-1 US	0.5	6.43	Clear	Not attributable to the project, it is upstream from the project.
Monthly	17/01/2024	WC 4-1 US	4.6	6.27	Clear	Not attributable to the project, it is upstream from the project.
Monthly	12/02/2024	WC 1-3 DS	2.69	9.12	Clear	FH completed pH tests upstream of the project, upstream was pH 9. High pH water was observed from upstream, there is a less than 1 pH unit difference, resulting in a minor exceedance.
		WC 4-1 US	0.6	6.17	Clear	Not attributable to the project, it is upstream from the project.
>25mm in 24 hours	15/02/2024	WC 1-1 US	117.14	6.92	Clear	High sediment load in creeks due to basins overtopping after receiving 39mm
		WC 1-3 DS	72.17	8.94	Clear	
		WC 3-2 DS	114.33	6.48		
		WC 4-2 DS	152.22	6.5	Brown	
		WC 4-3-US	263.64	6.33	Brown	
		WC 5-1-DS	25.85	5.99	Clear	
		WC Blue Wren Ck-DS	525.67	6.62	Brown	
		WC Ironbark Ck-DS	208.16	6.57	Light brown	

2.1.3 Groundwater

All the groundwater monitoring wells were installed by Transport prior to Fulton Hogan being awarded the contract. At the commencement of the reporting period in February 2023 (pre-construction), 17 of 23 monitoring wells were monitored, six were not able to be located due to being inside a neighbouring construction project, unable to be located in the surrounding bushland or locks not able to be opened. As clearing commenced on 16 March 2023 and progressed through the approved projects clearing limit, groundwater monitoring wells located within the clearing boundary were decommissioned (refer to Appendix A). Twelve groundwater monitoring wells were decommissioned as of July 2023. Eleven groundwater monitoring wells remained for monitoring for the duration of construction. In consultation with a Hydrogeologist, it was deemed that the remaining groundwater wells were adequate for the construction groundwater monitoring program.

2.1.3.1 Groundwater sampling

In the reporting period, five groundwater sampling events occurred, including the one month prior to construction commencing in February 2023.

2.1.3.2 Groundwater elevation

In the reporting period, six groundwater sampling events occurred, including the one month prior to construction commencing in February 2023. The six events included the manual groundwater elevation measurements and downloading the continuous dataloggers.

2.1.3.3 Trends

No exceedances were reported during the reporting period for arsenic, boron, cadmium, chromium and Iron.

Aluminium

Concentrations were reported above the ANZG (2018) criteria in groundwater at 3 locations (BHMW303 – February and May 2023, BHMW309 – February 2023 and BH307 – February 2023) all were pre-construction results from February 2023, with one exceedance in May 2023, however consistent with pre-construction monitoring results.

Copper

Concentrations of copper were reported above the ANZG (2018) criteria at some groundwater locations. Concentrations were consistent with pre-construction results during the reporting period. Exceedances of the pre-construction baseline data were minor and are likely due to natural fluctuations.

Lead

There was one concentration of lead reported above the ANZG (2018) criteria at BHMW309 in August 2023. The exceedance is within the pre-construction baseline data.

Manganese

There was one ANZG exceedance of manganese at BHMW303 In February and May 2023. The exceedances are consistent with the baseline data for BHMW303.

Nickel

Concentrations of nickel were reported above the ANZG (2018) criteria at all groundwater monitoring locations, with the exception of BHMW317. All nickel concentrations in groundwater were stable and below the pre-construction baseline maximum during the reporting period.

Zinc

Concentrations of zinc were generally stable during the reporting period. Exceedances of the ANZG guidelines were minor, with the majority of exceedances occurring during periods of high rainfall.

Total Nitrogen

Concentrations of nitrogen were variable during the reporting period. Given the site is in an urban setting, nitrogen concentrations would be anticipated to fluctuate significantly with nutrient laden stormwater runoff from urban environments. It is therefore possible that detected elevated nutrient concentrations are reflective of the wider environment.

Phosphate (as P) (Total Phosphorus)

Concentrations of phosphorus were variable during the reporting period. Given the site setting in a heavily disturbed urban environment, phosphorus concentrations would be anticipated to fluctuate significantly with nutrient-laden stormwater runoff from urban environments.

pH

Five exceedances occurred that exceeded the ANZG criteria and were not consistent with the pre-construction monitoring data. ANZG criteria exceeded at WC 1-3-DS in November and December were a result of the upstream catchment measured at above the ANZG criteria. At WC 3-2-DS the <6.5 pH results are a result of discharges from the basin upstream of the project. Refer to Table 2-2 for further information of pH exceedances.

2.1.4 Sediment basin discharge

The Project Environmental Protection Licence (EPL) prescribes water quality parameters to be measured and associated discharge criteria. For each sediment basin specified in the EPL, the concentration of a pollutant discharged at that point, must not exceed the concentration limits specified for that pollutant as shown in Table 2-3.

Table 2-3 Environmental Protection Licence concentration limits

Pollutant	Units of Measure	100 percentile concentration limit
Oil and Grease	Visible	Nil
pH	pH	6.5-8.5
Turbidity	Nephelometric turbidity units	46

Fulton Hogan released 132 compliant discharges from sediment basins during the reporting period. No exceedances have been recorded against the EPL criteria. Sediment basin discharge data can be found at https://www.fultonhogan.com/managementplans/newcastle-inner-city-bypass-rankin-park-to-jesmond/.

2.1.5 Conclusion

Following rainfall events, particularly during October and November, numerous analyte and parameter exceedances including Cadmium, Lead, Aluminium, Zinc, turbidity and pH were reported greater than the laboratory LOR and/or the adopted criteria. This is likely reflective of runoff from the surrounding urban environment, as well as a flush-out of settled debris and sediment build-up along creek lines.

Overall, the majority of analytes were reported below the adopted ANZG (2018) criteria and preconstruction baseline data during the majority of sampling events. Several exceedances were reported during the reporting period; however, these exceedances are potentially attributable to the urban setting of the site (including stormwater runoff from surrounding residential and commercial premises and roadways), natural seasonal fluctuation of background concentrations of contaminants, and the build-up of debris and sediments within creek lines during dry periods (which is flushed into creek lines in stormwater during rainfall events). One minor pH exceedance of 9.7 pH was noted at WC 1-3DS. Fulton Hogan completed an upstream sample, and it was exceeding the criteria of 6.0-8.0 at 9.7 pH. As it is less than 1 pH unit above background it is considered a minor exceedance. No exceedance identified was able to be directly or definitively attributed to site operations.

Overall, the water quality results are consistent with the summary provided in the SGWQCMP for the baseline data. Results obtained above the adopted performance criteria were primarily attributable to natural seasonal fluctuations or background concentrations for the urban setting of the site.

2.2 Air Quality

The Construction Air Quality Monitoring Program (AQMP) as part of the Air Quality CEMP Sub-plan has been prepared for implementation during construction of the Newcastle Inner City Bypass – Rankin Park to Jesmond (RP2J) to describe how Fulton Hogan will monitor air quality impacts.

As required by the AQMP, an annual monitoring report has been prepared for the reporting period, and is outlined in Table 2-4.

This section includes the following objectives:

- Data summary tables from monitoring undertaken in the reporting period
- Exceedances and management responses to any exceedances which may have occurred during the reporting period.

Baseline ambient air quality or meteorological monitoring has not been undertaken at the Project prior to construction commencing. The nearest Environment Protection Authority (EPA) managed ambient air quality

monitoring station (AAQMS) to the Project is located at the swimming pool in Wallsend, about 2.3 kilometres to the north-west at height of 8 metres Australian Height Datum (AHD). The Wallsend AAQMS is a NEPM performance AAQMS and monitoring is undertaken in accordance with relevant Australian Standard methods. The AAQMS was commissioned in 1992 and monitors for a range of air quality and meteorological parameters including (Particulate Matter (PM)10, PM2.5, wind speed and wind direction. These parameters were analysed in further detail for the years 2016 to 2020 and are summarised in section 2.2.1and have been compared to 2023 since construction has commenced. This analysis has been conducted for the Project prior to construction and satisfies the requirement to complete baseline monitoring.

The purpose of air quality monitoring during the construction phase is to monitor air emissions generated by the Project during construction and to ensure they are minimised and comply with the Project assessment criteria. Monitoring was carried out to assess compliance with assessment criteria and in response to complaints.

Table 2-4 Air monitoring program

Monitoring Type	Frequency*	Location	Comments	Section addressed of this report
Depositional dust	Monthly	Depositional dust gauges at 4 locations	Analysed by NATA accredited laboratory	Section 2.2.6
Meteorological conditions	Continuous	Project Automatic Weather Station	Averaged over a 5-minute period (rolling calculation for rainfall intensity)	Section 2.2.2
Odour	Daily during excavation of contaminated material	Location of contamination	Conducted by trained personnel	Section 2.2.4
Visual inspections	Weekly or daily during dust generating activities	As per Section 7.4 of the air quality construction monitoring program	Conducted by trained personnel	Section 2.2.5
Complaint monitoring	As required	In the event that a complaint is made from a member of the public about dust, monitoring will be undertaken to determine the veracity of the complaint.		Section 2.2.3 and 2.2.6

2.2.1 Weather during the reporting period

Weather during the reporting period was about the average rainfall when compared against the mean rainfall; between 1929-2023. This is summarised in Table 2-5.

Table 2-5 Summary of rainfall recorded at Jesmond weather station

Month	Rainfall total (mm) – Jesmond	Average (1923-2023)
February 2023	70.0*	107
March 2023	100.4*	119.1
April 2023	109.2	116
May 2023	83.0	115.8
June 2023	3.6*	117.1
July 2023	32.4	92.6
August 2023	79.6	72.0
September 2023	41.6	71.3
October 2023	65.4	73.0
November 2023	138.0	71.6
December 2023	60.0	78.8
January 2024	27.2	66.9
February 2024	148.0	87.8

* Nobbys signal station AWS

Figure 2-1 Dust deposition gauge

The key emissions from road construction are generally dust and PM. The EPA sets goals for ambient dust concentrations and dust deposition, which is a measure of the impacts of nuisance. Air quality goals relate to the total dust burden in the air and not just from the project. Because of this, there needs to be some consideration of background levels. Particulate levels ($PM_{2.5}$ and PM_{10}) do exceed national standard levels from time to time.

Table 2-6 Ambient air quality monitoring data at Wallsend AAQMS comparing to the EIS data

Year	Annual Average (µgm^3)		Maximum 24-hour average (µgm^3)		
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	Number and dates of exceedances
2016	16.6	8	65.5	50.7	PM_{10}: 1 (maximum on 7 November) $PM_{2.5}$: 1 (maximum on 7 November)
2017	17.4	7.3	47.9	20.4	PM_{10}: 0 $PM_{2.5}$: 0
2018	19.4	7.3	136.5	20.2	PM_{10}: 5 (maximum on 22 November) $PM_{2.5}$: 0
2019	22.8	10.4	127.9	108.3	PM_{10}: 21 (maximum on 5 December) $PM_{2.5}$: 19 (maximum on 5 December)

2020	17.7	7.3	77.9	56.8	PM_{10}: 6 (maximum on 8 January) $PM_{2.5}$: 5 (maximum on 8 January)
2021	14.7	6.1	33	21.4	PM_{10}: 6 (maximum on 31 January) $PM_{2.5}$: 5 (maximum on 31 January)
2022	12.7	5.1	27	18.7	PM_{10}: 0 $PM_{2.5}$: 0
2023	16.1	6.1	39	16.5	PM_{10}: 0 $PM_{2.5}$: 0
Air NEPM Standard	25	8	50	24	

The comparison of $PM_{2.5}$ has been found to typically include ammonium sulphate, sea salt, black carbon, organic matter and soil. This indicates that particle and gaseous emissions from natural and human-made sources contribute to ambient $PM_{2.5}$ conditions. Exceedances of particle standards often coincide with regional dust storms or bushfire/back burning events. Major source groups contributing to $PM_{2.5}$ and PM_{10} emissions in Newcastle LGAs are industrial sources (i.e. EPA-licensed industry), on-road mobile sources (e.g. cars and trucks), domestic–commercial sources (e.g. residential heating during the cooler months), commercial activities (e.g. service stations) and natural sources (e.g. vegetation, bushfires and sea salt). The major sources of particle emissions are industrial (70% of $PM_{2.5}$ and 81% of PM_{10} emissions) and domestic-commercial sources (12% of $PM_{2.5}$ and 20% of PM_{10} emissions). Iron and steel production and mining and extractive activities account for the bulk of industrial emissions. Residential wood heating accounts for over 90% of particle emissions from domestic-commercial sources. Due to increases in residential wood heating, Environment, Energy and Science (EES) (formally Office of Environment and Heritage) have noted a 24% increase in fire particle emissions from domestic-commercial sources.

Industrial emissions are the dominant source of $PM_{2.5}$ emissions in Newcastle LGA, followed by domestic–commercial emissions . Industrial emissions are the most significant source of PM_{10} emissions, accounting for 75% to 86% of total PM_{10} emissions in the three LGAs, followed by domestic–commercial emissions, accounting for 10% to 13% of total emissions. The top individual source type contributing to $PM_{2.5}$ and PM_{10} emissions by LGA are vehicles on Lookout Road, Croudace Street and Newcastle Road generating particulate matter and exhaust emissions.

Deposited dust is monitored monthly during construction using gravimetric Dust Monitoring Gauges (DMG) to assess compliance with the criteria detailed in Table 2-7. The air quality assessment criteria for insoluble matter is 4 g/m^2/month.

Table 2-7 Air quality assessment criteria

Location	Indicator	Units	Criterion	Averaging period
Site boundary/nearest sensitive receptor	Deposited dust	g/m^2/month	4	12 months

2.2.2 Meteorological monitoring

Two weatherlink weather stations have been deployed within the project area to continuously monitor the required weather information. One weather station is located at the Jesmond compound and the second is located at 136 Lookout Road New Lambton Heights.

2.2.3 Monitoring methods

During the reporting period, deposited dust in g/m^2/month was monitored monthly at four locations. In an event that a complaint is made from a member of the public about dust, a Dustrak is utilised to undertake real-time observation. Activity-based monitoring was generally conducted at the nearest downwind sensitive receiver on a monthly basis.

Complaint-based attended monitoring was undertaken in response to community complaints. Measurements were taken for PM10 for a fixed period of 15-minutes using a DustTrak.

2.2.4 Odour

No contaminated material-causing odour has been found on site, no odour monitoring has been completed for the reporting period.

2.2.5 Visual inspections

The environmental team do weekly inspections and complete daily inspections when on site each day. When additional mitigation measures are required due to dust generating activities, the environmental team will speak to the site team to modify construction methodologies or call additional water carts to supress dust.

2.2.6 Results

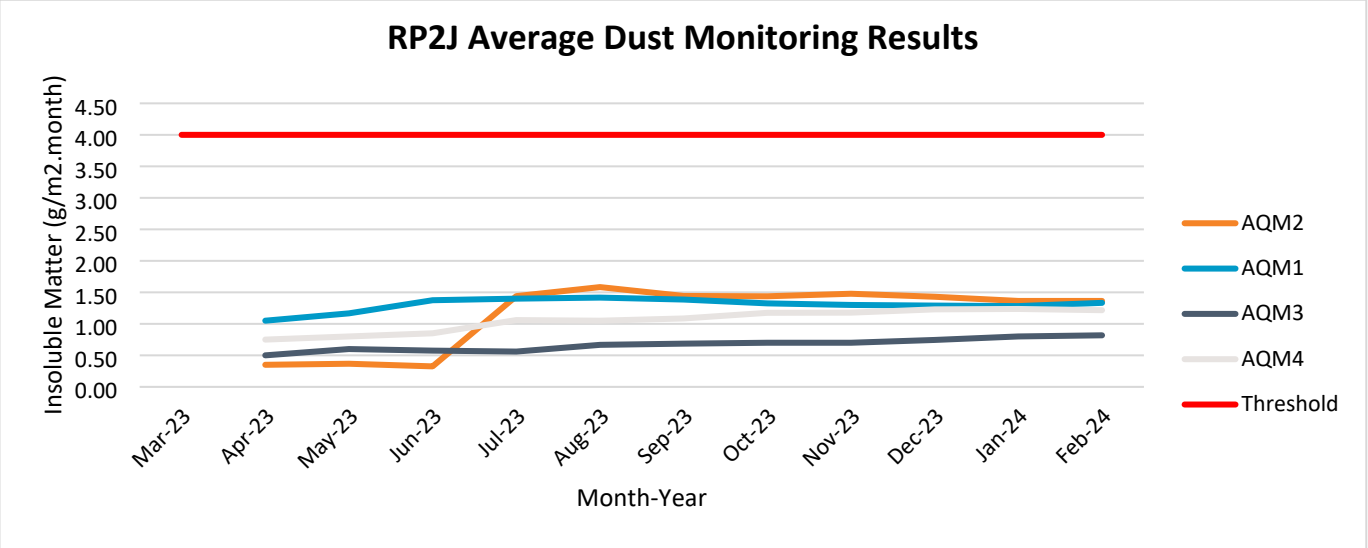
In general, Air Quality levels recorded at the Projects monitoring stations are consistent with the Wallsend AAQMS and the results are considered to be reflective of regional background conditions, rather than construction impacts.

The monthly dust deposition results as shown in Table 2-8 and Graph 1 are consistent with the anticipated impacts described in the Construction Air Quality Monitoring Program. These values show the results are below the 4 g/m²/month (Annual) anticipated maximum total deposited dust level and are consistent with pre-construction levels.

Table 2-8 Deposited dust criteria and recorded data

Month	Date started	Date finished	Criteria (g/m2/month) Annual	DMG1		DMG2		DMG3		DMG4	
				Monthly	Rolling average	Monthly	Rolling average	Monthly	Rolling average	Monthly	Rolling average
March	3/03/23	4/04/23	4	1.4	-	0.5	-	0.7	-	0.8	-
April	4/04/23	5/05/23	4	0.7	1.05	0.2	0.35	0.3	0.5	0.7	0.75
May	5/05/23	6/06/23	4	1.4	1.17	0.4	0.37	0.8	0.6	0.9	0.80
June	6/06/23	3/07/23	4	2	1.38	0.2	0.33	0.5	0.58	1	0.85
July	3/07/23	2/08/23	4	1.5	1.40	5.9	1.44	0.5	0.56	1.9	1.06
August	2/08/23	31/08/23	4	1.5	1.42	2.3	1.58	1.2	0.67	1	1.05
September	31/08/23	29/09/23	4	1.2	1.39	0.6	1.44	0.8	0.69	1.3	1.09
October	29/09/23	31/10/23	4	0.9	1.33	1.4	1.44	0.8	0.70	1.8	1.18
November	31/10/23	29/11/23	4	1.1	1.30	1.8	1.48	TMP*	0.74	1.2	1.18
December	29/11/23	2/01/24	4	1.2	1.32	1	1.43	1.1	0.8	1.7	1.23
January	2/01/24	2/02/24	4	1.2	1.27	0.7	1.36	1.3	0.76	1.3	1.24
February	2/02/24	4/03/24	4	1.9	1.29	TMP*	1.36	1	0.76	1	1.22
Annual average				1.33		1.36		0.82		1.22	

*DMG tampered with, no result recorded



Graph 1 Average annual dust deposition rolling results per month

No exceedances of $PM_{2.5}$ or PM_{10} were recorded during the reporting period at the Wallsend AAQWS.

No exceedances against the criteria identified in the monitoring program have occurred during the reporting period for deposited dust levels as shown in Table 2-8 and Graph 1.

Baseline data for the Wallsend AAQMS, as presented in the Air Quality Construction Monitoring Program Rev H (AQCMP, TfNSW 2023) provided data from 2016 to 2020. Table 2-9 presents this data with the addition of Wallsend AAQWS data through to 2023. Results show no increase above background (pre-construction years) for either annual or maximum 24-hour average PM_{10} or $PM_{2.5}$ and all data was below Air NEPM standards. Additionally, the Wallsend station recorded no maximum 24-hour average exceedances during 2023.

Attended dust monitoring has occurred 14 times in response to community enquiries. All dust levels were within acceptable limits, except for one occurrence of a minor exceedance on 21 September 2023 at 321 McCaffrey Drive. Additional mitigation measures were implemented including moxies stopping and pausing works to review dust mitigations, increasing polymer application around the southern interchange and permanent landscaping of the fill 1 batter commenced. Attended dust monitoring for the reporting period is presented in Table 2-9.

Table 2-9 Attended dust monitoring in response to community enquires

Location	Date	Average (mg/m^3)	Maximum (mg/m^3)	Exceedance on average of 0.05 mg/m^3
319 McCaffrey Dr	28/06/2023	0.012	0.061	No
319 McCaffrey Dr	28/06/2023	0,015	0.091	No
321 McCaffrey Dr	23/08/2023	0.015	0.159	No
Lookout Rd	23/08/2023	0.011	0.063	No
121 Lookout Rd	28/08/2023	0.022	0.151	No
321 McCaffrey Dr	28/08/2023	0.017	0.08	No
321 McCaffrey Dr	21/09/2023	0.055	0.682	Yes
121 Lookout Rd	21/09/2023	0.026	0.067	No
121 Lookout Rd	21/09/2023	0.032	0.116	No
121 Lookout Rd	21/09/2023	0.03	0.086	No

Location	Date	Average (mg/m^3)	Maximum (mg/m^3)	Exceedance on average of 0.05 mg/m^3
121 Lookout Rd	5/10/2023	0.008	0.01	No
321 McCaffrey Dr	5/10/2023	0.031	0.178	No
Gate 4	25/10/2023	0.039	0.137	No
321 McCaffrey Dr	25/10/2023	0.046	0.170	No

2.2.7 Conclusion

Monthly dust deposition monitoring results shown in Table 2-8 and Graph 1 were less than the nominated project criteria 4g/m2/month identified in the AQMP. The recorded rolling annual averages are less than the criteria identified in the AQMP and shown in Table 2-8. There was one exceedance during attended dust monitoring as shown in Table 2-9 additional mitigation measures were applied.

Wallsend AAQWS data for 2023 showed no increase in PM_{10} or $PM_{2.5}$ against pre-construction years.

Implementation of the standard mitigation measures listed in Table 6-1 of the AQMP ensure air quality impacts are minimised during construction. Minor modifications of work practices have occurred during the reporting period including changes to the construction methods and environmental control measures have assisted in mitigating air quality impacts from the project.

2.3 Noise and Vibration

The Noise and Vibration Management Plan (NVMP) has been developed in consultation with relevant council and Health Administration Corporation in accordance with CoA C4. The recommended management levels and goals when assessing construction noise and vibration are outlined in:

- The Interim Construction Noise Guideline (ICNG)
- The Transport for NSW Construction Noise and Vibration Guideline (CNVG)
- Environmental Noise Management Assessing Vibration: A Technical Guideline
- Assessing Vibration: A technical guideline
- The ANZECC, Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration.

Construction activities generate noise and vibration of varying levels depending on the activities being carried out and the proximity to sensitive receivers such as residential areas. The type of work carried out during construction often involves the use of large plant and machinery, sometimes moving along the project alignment and sometimes working in a fixed location, which can cause varying noise and vibration at nearby receivers. These aspects of construction can exacerbate noise levels from the works and their effects, causing annoyance to those affected.

Background noise monitoring was conducted as part of the NVMP for the Project between 5 June 2015 and 26 June 2015. The results of the monitoring of existing noise levels, referred to as rating background levels (RBL) are presented in Table 5 of the NVMP. The RBL is a measure of the typical background ambient noise level in the environment.

The noise monitoring program is included in Table 2-10 and the vibration monitoring program is included in Table 2-11.

Table 2-10 Noise monitoring procedure

Monitoring details	Frequency	Test procedure	Section addressed
Attended noise monitoring at sensitive receiver locations identified in Section 9.4.3 of Appendix C of the NVMP	Monthly	Test method to comply with AS 1055:2018 and includes: ▪ Sound level meter configured for "Fast" time weighting and "A" frequency weighting ▪ To minimise the influence of reflected sound, the measurement will be carried out at least 3.5 m from any reflecting surface (other than the ground) where possible. ▪ Tests will not be carried out during rain or when the wind speed at the test site exceeds 5m/s ▪ Conditions such as wind velocity, wind direction, temperature, relative humidity and cloud cover will be recorded. ▪ Monitoring period should be sufficient such that the measured noise levels are representative of the noise over a 15-minute period ▪ At a minimum Leq, Lmax, L10 and L90 levels will be measured and reported ▪ The observations of the person undertaking the measurements will be reported including audibility of construction noise, other noise in the environment and any discernible construction activities contributing to the noise at the receiver	Section 2.3.1and Appendix C
OOHW noise monitoring at sensitive receivers	As required: during OOHW		Section 2.3.1 and Appendix C-13
In response to a noise complaint; ▪ If monitoring is considered an appropriate response to determine if noise levels exceed predicted 'worst case' construction noise levels	As required		Section 2.3.4and Appendix C-13
Spot checks of noise intensive plant unless previously measured	Monthly – for construction activities predicted to exceed NML's	The test procedure for construction plant will follow the stationary test procedures according to Australian Standard AS 1055:2018: ▪ Sound level meter configured for "Fast" time weighting and "A" frequency weighting ▪ The test environment will be free from reflecting objects ▪ Tests will not be carried out during rain or when the wind speed at the test site exceeds 5 m/s ▪ The influence of noise from sources other than the source of interest shall be minimised and quantified in accordance with the methodology outlined in AS1055:2018.	Appendix C-14
Where required; ▪ Refining construction methods ▪ To reduce noise levels	As required		Section 2.3.5

Monitoring details	Frequency	Test procedure	Section addressed
		▪ Leq and L10 levels will be measured and reported.	
To manage cumulative impacts from the RP2J and John Hunter Health and Innovation Precinct (JHHIP) projects	As required	Continuous (unattended) noise monitoring to manage cumulative impacts in consultation with Health Administration Corporation if deemed necessary during the ongoing RP2J JHHIP Project Control Group (PCG) meetings.	Section 2.3.1.2

Table 2-11 Vibration monitoring procedure

Monitoring details	Frequency	Test procedure	Section addressed
Background monitoring at the sensitive equipment locations in the John Hunter Hospital precinct as identified in Section 9.4.3 to confirm the baseline/ existing ambient vibration levels	Prior to construction works in the area	Attended vibration monitoring will be undertaken when checking the safe working distances from construction plant or in response to a complaint. The testing method includes: ▪ Transducer to be affixed to ground or building in general accordance with AS 2775-2004 ▪ Monitoring to be conducted for at least three distances from the plant, including a representative distance for the nearest sensitive structures and/or receivers ▪ The testing will be conducted at each location to obtain a suitable representation of the range of vibration levels that would occur from the tested plant ▪ Peak (PPV) vibration levels and the dominant frequency of the vibration will be recorded for assessment against the structural and cosmetic damage criteria. In situations in which human comfort is also of concern then the rms vibration level should also be recorded.	Section 2.3.2
At the commencement of vibratory compaction work within 18 m of residential buildings	As required		N/A No works within 18m of residential buildings
Where a valid complaint is received in relation to human exposure to vibration levels and monitoring is considered an appropriate response	As required		N/A No works within 18m of residential buildings
Where a valid complaint is received in relation to suspected property damage due to vibration impacts and monitoring is considered an appropriate response	As required		Section 2.3.4

Where an activity may occur within safe working distances for cosmetic damage for no more than one day continuously	As required		N/A No works within the safe working distances for cosmetic damage for more than one day continuously
To confirm safe working distances and refine construction methods if vibration levels exceed guideline values/ limits for sensitive equipment	As required		Not required – vibration has not exceeded
Where an activity may occur within safe working distances for sensitive equipment or cosmetic damage (specified in Table 32) for a period of more than one day continuously	As required	▪ Continuous (unattended) vibration monitoring will be undertaken in situations where there is a risk that vibration from a particular construction activity may exceed the sensitive equipment or cosmetic damage criteria at a sensitive structure. This will be where activities may occur within the safe working distances for sensitive equipment or cosmetic damage identified in Table 32 (NVMP). ▪ Transducer to be affixed to ground or building in general accordance with AS 2775-2004 ▪ Vibration logger to continuously measure vibration level while the relevant works are occurring within the safe working distance for sensitive equipment or cosmetic damage ▪ Measurement to be conducted as close as possible to the sensitive equipment/ structure. ▪ A warning system will be implemented with the monitoring system including one or both of the following: – audible and/or visual warning alarm – SMS and/or email alerts to site personnel	Section 2.3.2.2
To manage cumulative impacts from the RP2J and JHHIP projects	As required	Continuous (unattended) vibration monitoring to manage cumulative impacts in consultation with Health Administration Corporation if deemed necessary during the ongoing RP2J JHHIP Project Control Group (PCG) meetings.	Section 2.3.2.2

Dilapidation surveys of buildings and structures (also known as Building and Structure Condition Surveys) where construction works occurs within the safe working distance for cosmetic damage, or if modelling (or desktop estimates), or monitoring indicates that vibration levels will be exceeded.	Prior to construction works/ Post construction	At a minimum, dilapidation surveys and reports will comprise: ▪ A visual inspection of the structure, including all internal and external walls, ground level floors and external pavements, all connections of other structures above ground level and their connection at ground level and any exposed foundations at 18 m from buildings, within the minimum working distances for sensitive equipment or areas in the John Hunter Hospital precinct or if monitoring indicates that vibration levels are exceeded. ▪ Full written building Condition Survey Report outlining the condition of the internal and external components of each property ▪ A series of photographs of each identified defect/crack ▪ Identification of any condition changes relative to Pre-Construction and the likely cause of the change (Post-construction only)	Section 2.3.3

The Fulton Hogan Environmental Officer undertakes attended noise monitoring at 10 nominated locations (shown in Appendix A) listed below, monthly during the construction phase of the Project as stated in section 9.4.1 and 9.4.3 of the NVMP. These locations have been selected considering the proximity of each Noise Catchment Area (NCA) to key construction zones. They are considered to be representative of the most potentially affected sensitive receivers based on the outcomes of the EIS construction noise assessment. The catchments are described in section 4.2 of the NVMP and shown in Appendix C.

The noise monitoring program requires the following locations to be monitored monthly:

- Location L04: 53 Robert Street
- Location L05: 4 Crest Road
- Location L06: 11 Myall Street
- Location L08: 17 Minimbah Street
- Location L09: 40 Roberts Circuit
- Location L10: 12 Sygna Close
- Location L11: Yallarwah Cottage (John Hunter Hospital precinct)
- Location L12: Ronald McDonald House (John Hunter Hospital precinct)
- Location L15: 45 Kingsway Avenue
- Location L18: 121 Lookout Road.

Out of Hours Work (OOHW) is required due to road occupancy license (ROL) restrictions around McCaffrey Drive, Newcastle Road and the Newcastle Inner City Bypass. Road occupancy is restricted during standard construction hours. Attended monitoring has been undertaken during approved OOHW.

Effects of ground vibration on buildings resulting from construction may be segregated into the following three categories:

- Human exposure – disturbance to building occupants: vibration in which the occupants or users of the building are inconvenienced or possibly disturbed
- Effects on building contents – vibration where the building contents may be affected
- Structures – vibration in which the integrity of the building or structure itself may be prejudiced.

The vibration monitoring program requires background vibration monitoring (at the sensitive equipment locations in the John Hunter Hospital precinct) to confirm the baseline/ existing ambient vibration levels at the following locations (shown in Appendix B):

- Location V1: HMRI Building
- Location V2: Level 2 Allied Health – Speech Pathology and Level 2 Sleep Lab
- Location V3: Level 3 Theatres (i.e. above Level 2 Emergency Department – Medical Imaging and Level 2 Medical Imaging)
- Location V4: Level 3 Theatres
- Location V5: Level 2 Hunter Area Pathology Service (HAPS)
- Location V6: Forensic Medicine.

Figure 2-2 Attended vibration monitoring

2.3.1 Noise

2.3.1.1 Attended noise monitoring

Attended (refer to Figure 2-3) and unattended noise monitoring is undertaken to assess the influence of specific noise sources such as construction works, however background noise sources can influence the attended monitoring session. L(A)eq 15min represents the continuous sound level recorded at the time of monitoring including external (i.e. not construction) influences such as traffic, heavy industry, commercial or private impacts.

During construction when complaints were received or any exceedances were observed, refining and changing the construction methodology was considered. Some that were implemented included:

- Changed fill 1 works from using a D10 bulldozer to a compactor to minimise noise based impacts on the noise results and complaints
- Discussions with site team about using smaller excavators / vibratory rollers to minimise noise
- Refined construction methods by reducing high impact noise from activities like hammering and concrete saw cutting

Results from monthly and out of hours attended and unattended monitoring can be found in Appendix C of this report.

During the reporting period, noise monitoring took place during the morning, day, evening and night-time periods for assessment against the NMLs and predicted noise levels. Where noise measurements were undertaken within close proximity to public roads that generated an elevated level of ambient noise, the construction contribution of noise throughout the 15-minute period was reviewed to assess for compliance. Actual noise levels were consistent with the NMLs, meaning the correct mitigation measures had been implemented throughout the reporting period. A summary of the attended noise monitoring results is provided in Appendix C.

Figure 2-3 Attended noise monitoring

2.3.1.2 Unattended noise monitoring

Real time noise monitoring data was collected to assess and confirm is noise emissions from site are within the predicted levels at the locations shown in Appendix C. Unattended noise monitors (SiteHive) were installed within the John Hunter Hospital at locations outside the project boundary identified by the hospital as sensitive locations. The fixed unattended noise monitors are detailed in Table 2-12.

Table 2-12 SiteHive noise monitor locations

Monitor location	Latitude	Longitude
RSU building	-32.920704	151.69046
HRMI	-32.920647	151.69072
Ronald McDonald	-32.925	151.6944

Due to the monitors being in close proximity to high traffic and pedestrian areas in the hospital, noise exceedances were often caused by noise emitting traffic and pedestrians. The noise monitors are also located next to the JHHIP, which contributes to the exceedances shown in Appendix C. The attended noise monitoring (refer to Section 2.3.1.1) confirmed the unattended noise monitoring results, that exceedances were contributed by the JHHIP works and not contributed by the RP2J project. Unattended noise monitors detect all ambient noise and onsite noises that may be in close proximity to the noise monitor. As such, some brief peaks on the unattended monitoring are anticipated. The summary of results are presents in Table 2-12, with the results in Appendix C.

Table 2-13 Noise and vibration trends

Noise criteria period	NML dB(A)	Predicted noise levels dB(A) at site hive location	Recorded average dB(A)
RSU building			
Day	48	71	51
Evening	42	63	46
Night	40	61	45
HRMI			
Day	48	71	46
Evening	42	63	45
Night	40	61	42
Ronald McDonald House			
Day	48	71	50
Evening	42	63	48
Night	40	61	45

2.3.1.3 Semi-mobile station (real time) noise monitoring

During the reporting period, the real time semi-mobile monitor was deployed at several locations. These locations were identified based on:

- Noise impacts for work activities
- Proximity to regular complainants
- Response to noise complaints.

The monitoring details completed are included in Appendix C.

2.3.1.4 Plant/equipment noise checks

Noise monitoring spot checks were conducted on plant and equipment to validate assumptions made in the noise modelling. During the reporting window, five plant/equipment noise checks were completed on a vacuum truck, tunnel fans, compressors and the driven piling rig. All measurements indicated compliance with the sound power levels as illustrated in the CNVIS or EMM NoiseCheck Model.

Monitoring was conducted in the safest location available, for a 1 or 15 minute period and Sound Pressure Levels were converted into Sound Power Levels. Ongoing spot checks will be conducted where required.

2.3.2 Vibration

Vibration monitoring was conducted during the reporting period in accordance with vibration assessments and in response to complaints.

2.3.2.1 Attended vibration monitoring

Attended vibration monitoring has occurred three times during the monitoring period in response to community enquiries. Vibration levels were within acceptable parameters established in International Standards and adopted in the approved NVMP. The results are presented in Table 2-14.

Table 2-14 Attended vibration monitoring

Location	Date	Trigger exceedance	Exceedance above 20mm/s at 15Hz or 50mm/s at 40Hz	Comment
6 Udunda Place	6/09/2023	No	No	Drill rig, scrapers, compactors and pad foot in use
117 Lookout Road	6/10/2023	No	No	Vibratory Roller in use
7a Myall Street	6/10/2023	No	No	50t excavator, moxies, pad foot and grader in use

2.3.2.2 Unattended monitoring locations

Real time vibration monitoring data was collected to assess and confirm if vibration from site are within the predicted levels at the locations shown in Appendix C. Unattended vibration monitors (SiteHive) were installed within the John Hunter Hospital in August 2023 at locations identified by the hospital as sensitive locations. The fixed unattended vibration monitors are detailed in Table 2-15.

Table 2-15 SiteHive vibration monitor locations

Monitor location	Latitude	Longitude
Forensics	-32.921185	151.69063
Research Services Unit (RSU)	-32.920519	151.69056
HMRI	-32.920136	151.692734

Background monitoring at the sensitive equipment locations shown in Appendix C occurred in March 2023. A spot check of cumulative construction impacts was conducted in May 2023. The results are presented in Table 2-16. No complaints were received regarding vibration from the John Hunter Hospital precinct during the reporting period.

Table 2-16 John Hunter Hospital background vibration monitoring

Location description	Baseline (um/s) – March 2023	Spot check (um/s) – May 2023
V1: HMRI Building	79	35
V2: Level 2 Allied Health – Speech Pathology and Level 2 Sleep Lab	27	22
V3: Level 3 Theatres (i.e. above Level 2 Emergency Department – Medical Imaging and Level 2 Medical Imaging)	27	30
V4: Level 3 Theatres	30	32
V5: Level 2 Hunter Area Pathology Service (HAPS)	26	30
V6: Forensic Medicine	64	25

2.3.3 Dilapidation surveys

Dilapidation surveys of buildings and structures where construction works occurs within the safe working distance for cosmetic damage is required. Three-hundred and fifteen properties were eligible for dilapidation surveys based on buildings and structures being located within the safe working distance. Out of 315 eligible properties 266 properties accepted dilapidation surveys. Out of 315 eligible properties, 26 declined and 23 did not respond. Dilapidation surveys were completed for five buildings in the John Hunter Hospital. Prior to blasting 22 properties were identified as eligible for dilapidation survey. The 22 are incorporated into the 315 properties. The 22 properties were completed just before blasting commenced.

2.3.4 Complaints

During the reporting period, RP2J received 43 noise and vibration complaints. To assist in response to the complaints, works (including use of plants and equipment) was considered and previous noise or vibration data was reviewed to determine if the correct mitigation measures were in place.

2.3.5 Conclusion

Implementation of the standard mitigation measures listed in Table 33 and Table 34 of the NVMP ensure noise and vibration impacts are minimised during construction. Based on the available data, no modification is required to the construction methods or environmental control measures being implemented onsite.

The recorded levels during monthly attended noise monitoring are consistent with the predicted levels as described in Table 10 of the NVMP. The monthly attended noise monitoring for the reporting period is included in Appendix B.

The recorded levels during attended OOHW have been consistent with the predicted levels shown in the construction noise and vibration impact statement and noise model developed from Noise check. Exceedances have been recorded during attended noise monitoring as a result of traffic in both interchanges, along Lookout Road, McCaffrey Drive, Newcastle Inner City Bypass and Newcastle Road.

2.4 Flora and Fauna

The Flora and Fauna Construction Monitoring Program (FFCMP) was prepared in response to the NSW Conditions of Infrastructure Approval issued under s 5.19 of the Environmental Planning and Assessment Act 1979 (EP&A Act) (SSI 6888) and focuses on threatened biodiversity recorded as part of the Project Biodiversity Assessment (GHD, 2016a), SPIR Biodiversity Assessment (GHD, 2018) and Modification report for Additional Construction Compounds (Transport, 2021). Table 2-17 outlines the monitoring program approach and where each is addressed in this report.

Flora and fauna monitoring was completed for the reporting period by Fulton Hogan's sub-contractor Kleinfelder. An annual report has been produced by Kleinfelder and is included in Appendix D. A summary of the monitoring report is provided below.

The FFCMP outlines the surveys that would be conducted prior to and during the construction phase of the Project to assess the effectiveness of mitigation measures implemented to minimise adverse impacts to threatened biodiversity.

Flora and fauna monitoring will be implemented during the construction period and at least 12 months after completion of construction as per the frequencies identified in Table 2-17.

The monitoring aims to:

- Determine the effectiveness and uptake of the replacement habitat installed as a compensatory mechanism to minimise the impacts to microbats from the loss of hollows for the threatened species
- Determine any potential construction impacts on threatened flora and fauna.

2.4.1 Powerful Owl

Kleinfelder completed monitoring between 17 and 19 June 2023 and 21 to 23 August 2023 in accordance with the method outlined in the monitoring program.

The results indicate that there is, at a minimum, one male Powerful Owl in the area. It was heard calling and sited in close proximity to the identified nest tree NT1. The presence of a breeding pair could not be confirmed.

Without a known nesting site it is difficult to ascertain any impact to breeding Powerful Owls as a result of construction impacts by the Project. Future survey efforts may be required to further explore the area along the creek line where the male owl was heard calling.

2.4.2 Tetratheca juncea (Black-eyed Susan)

On 21 and 22 September 2023 Kleinfelder undertook flora surveys for on six patches of *Tetratheca juncea.* The results of the monitoring showed there was a decrease in three *Tetratheca juncea* patches (T1, T4, T5). The control site for *Tetratheca juncea* also showed about a 75% decline, suggesting the decline could be environmental and not necessarily construction related. The results identify a 25% reduction to baseline data, which is delineated as an adaptive management trigger for the surveys in the FFCMP in the instance that the decline is evidently related to the Project, which is not conclusive at this time.

2.4.3 Grevillea parviflora subsp. Parviflora

Between 21 and 22 September 2023 Kleinfelder undertook flora surveys on two patches of *Grevillea parviflora subsp. Parviflora.* Patch G1 showed about 39% decrease in population density. It cannot be concluded that the decrease in population density is a result of construction due to the monitoring not being completed during peak flowering season. It is suggested that the next round of monitoring is completed during peak flowering season to monitor the most accurate population numbers.

2.4.4 Grey-headed flying fox camp

Predicted levels did not exceed the NML by 10dBA LAeq during the reporting period. Monthly noise monitoring was completed each month during the reporting period on Lookout Road approximately 400m from the GHFF camp and there were no exceedances.

As the trigger for additional surveys was not exceeded, no further monitoring was undertaken for the GHFF.

The census data was reviewed and the Grey-headed flying fox colony has remained the same as pre-construction.

2.4.5 Replacement habitat

Between 25 and 29 September 2023 two Kleinfelder ecologists conducted habitat replacement surveys of the 178 nest boxes and carved hollows installed prior to construction commencing. Monitoring occurred during nesting

season for hollow-dwelling target species, Little Lorikeets (*Glossopsitta pusilla*), Powerful Owls and Squirrel Gliders (*Petaurus norfolcensis*).

Of the 178 habitat features installed, monitoring identified that only three features were being utilised and the species recorded weren't the threatened species targeted. Monitoring was undertaken within the first year after the installations were completed (approximately nine months), and this may have influenced the results with regards to occupation rate. Further to this, the placement of these features is outside the project boundary within the surrounding bushland, with some being within the project boundary and in close proximity to the clearing boundary and construction activities. The surrounding tracts of forest hold high levels of naturally occurring hollow bearing trees which allow numerous natural habitat features for existing wildlife.

It is challenging to draw any conclusions on the lower levels of occupation within the given timeframe of the installed features. Threatened species by their very nature can be reclusive and seek out denning and breeding habitat away from development, particularly construction, that involves increased noise and vibration.

Table 2-17 Flora and fauna monitoring program approach

Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Where addressed
Population density	*Tetratheca juncea*	Monitoring locations shown in Appendix A	During peak flowering between Sep – Oct	Annually; September/October until one year post-construction	Section 2.4.2 and Appendix D
	Grevillea parviflora subsp. parviflora	Monitoring locations shown in Appendix A	During peak flowering between Aug- Oct	Annually; September/October until one year post-construction	Section 2.4.3 and Appendix D
Population extent	*Tetratheca juncea*	T2-T5 within 50m corridor from the Project boundary and entire population within the Project Boundary at T1	During peak flowering between Sep – Oct	In response to a 25% reduction in population density at any one monitoring location until one year post-construction	Section 2.4.2 and Appendix D
Review of Noise monitoring results at NCA13	Ambient noise levels (Grey-headed Flying-fox)	Measuring noise levels in Noise Catchment Area 13	Anytime throughout the year	Monitoring will occur monthly as part of the Construction Noise and Vibration Monitoring Program (WSP, 2021a)	Section 2.4.4 and Appendix D
Review of Noise monitoring results at GHFF camp	Ambient noise levels during daytime (Grey-headed Flying-fox)	Noise levels at the GHFF camp during daytime	Anytime throughout the year	In response to noise levels at NCA13 measuring 10dB above project noise management levels during the daytime period	Section 2.4.4 and Appendix D
Grey-headed Flying-fox camp	Grey-headed Flying-fox (GHFF)	GHFF camp in Blackbutt Reserve	Anytime throughout the year	In response to project noise management levels exceeding threshold (10dB increase) at the GHFF camp during daytime. Repeated daily until project noise management levels return to below benchmark levels	Section 2.4.4 and Appendix D
Review of census data	Grey-headed Flying-fox (GHFF)	GHFF camp in Blackbutt Reserve	-	Census data in collected annually during November/December and January (CSIRO, 2011) and will be requested from DAWE	Section 2.4.4 and Appendix D

Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Where addressed
Stag watches	Powerful Owl	Nest tree (NT1) identified in Figure	During breeding season (1 July -31 Aug) over 3 consecutive nights	Maximum of twice a year; Initial surveys in July, if not recorded, surveys are repeated in August	Section 2.4.1 and Appendix D
Habitat replacement	Opportunistic sightings and fauna utilisation	Replacement habitat	Monitoring would coincide with nesting season for hollow-dwelling target species (July – September)	Monitoring the utilisation of all replacement habitat annually for the first two years after installation, skip third year and monitor again in fourth year	Section 2.4.5 and Appendix D
Emergence	Microbats	Dark Creek Culvert	Anytime throughout the year (higher likelihood of presence during winter)	Evening prior to grouting works occurring within the Dark Creek Culvert	Section 2.4.7 and Appendix D
Remote camera survey	Microbats	Dark Creek Culvert	-	During each morning of grouting works as per the Microbat Management Strategy	Section 2.4.7 and Appendix D
Post-completion of Dark Creek culvert	Microbats	Dark Creek Culvert	Daytime between March and November	Monthly for up to 24 months post completion of the new culvert[1]	Not applicable to the reporting period
Post-completion of Dark Creek culvert	Microbats	Dark Creek Culvert	Daytime between March and November	As soon as practicable after detection of microbats during remote camera survey carried out post-completion of the new culvert	Not applicable to the reporting period

1 Monitoring would cease if microbats are recorded in the new Dark Creek culvert

2.4.6 Conclusion and recommendation

The data collected from the survey aims to measure the impact of construction on breeding and nesting behaviours of the Powerful Owl pair that were recorded to occupy NT1 during the EIS. The results indicate that there is, at a minimum, one male Powerful Owl in the area, however presence of a breeding pair (as defined in Section 5.2.3.2 of the FFCMP) could not be confirmed. The survey could not conclude the presence of a female by call or by sight, and no two birds duetting could be heard. NT1 was not an active nest site and this may be due to degradation of the hollow.

In the 2023 survey, there are significant decreases in three *Tetratheca juncea* patches (T1, T4, T5; refer to Appendix A) and *Grevillea parviflora subsp. parviflora* patch G1. Notably, the control site for *Tetratheca juncea* also showed a significant decrease (-75%), suggesting the cause of the decline could be environmental (e.g. seasonal variation in peak flowering) and not necessarily construction related; *Tetratheca juncea* is difficult to detect when it is not in full flower. No ambient evidence or otherwise, such as observations relating to dust or dieback of other species at the monitoring locations, was recorded. The results identify a 25% reduction to baseline data, which is delineated as an adaptive management trigger for the surveys in the FFCMP in the instance that the decline is evidently related to the Project, which is not conclusive at this time.

Of the 178 habitat features installed, monitoring identified that only three features were being utilised and the species recorded weren't the threatened species targeted. Monitoring was undertaken within the first year after the installations were completed (approximately nine months), and this may have influenced the results with regards to occupation rate. Further to this, the placement of these features is outside the project boundary within the surrounding bushland, with some being within the project boundary and in close proximity to the clearing boundary and construction activities. The surrounding tracts of forest hold high levels of naturally occurring hollow bearing trees which allow numerous natural habitat features for existing wildlife.

It is challenging to draw any conclusions on the lower levels of occupation within the given timeframe of the installed features. Threatened species by their very nature can be reclusive and seek out denning and breeding habitat away from development, particularly construction, that involves increased noise and vibration.

Appendix A Monitoring programs locality maps

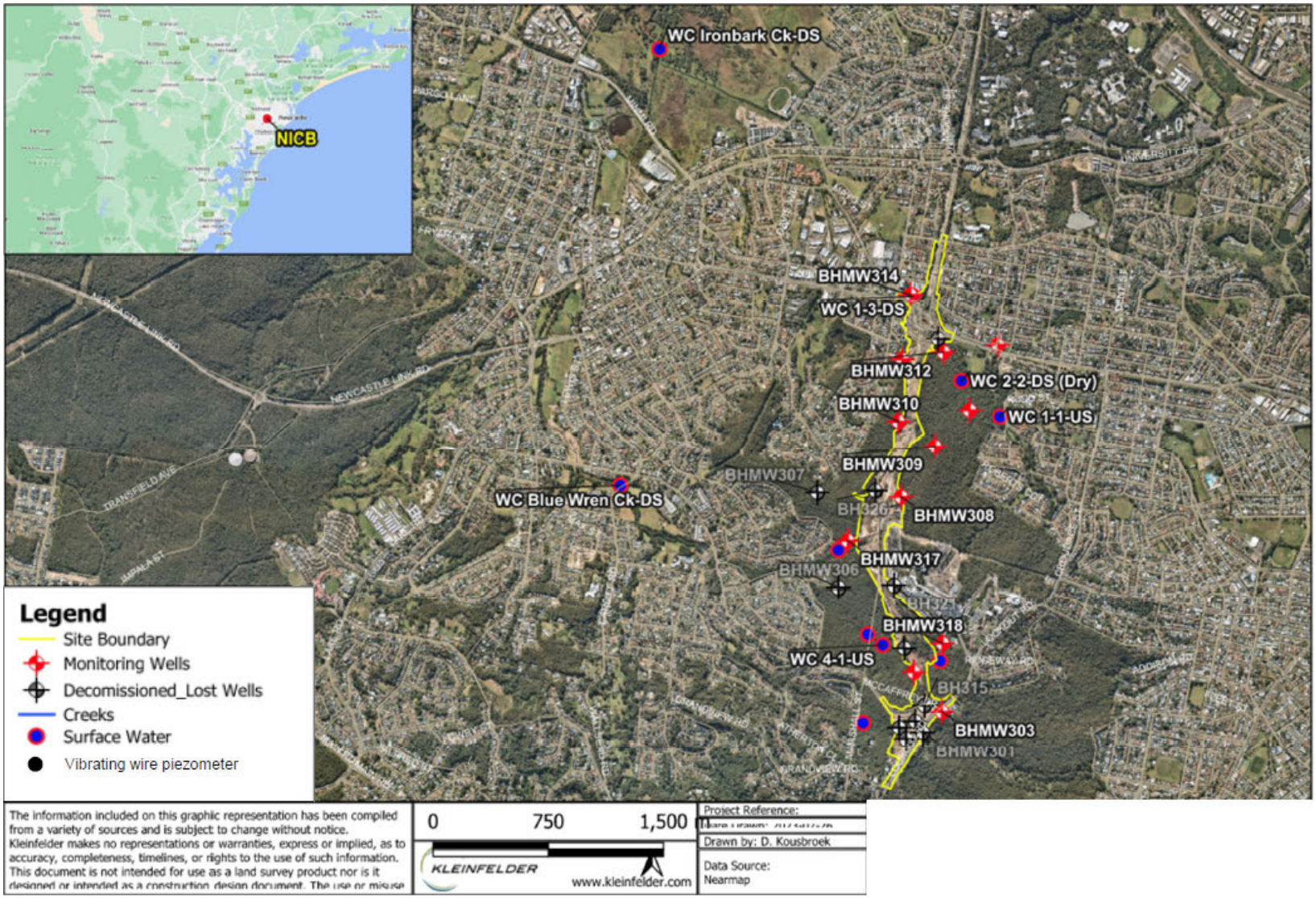


Figure A-1 Groundwater monitoring locations (July 2023)

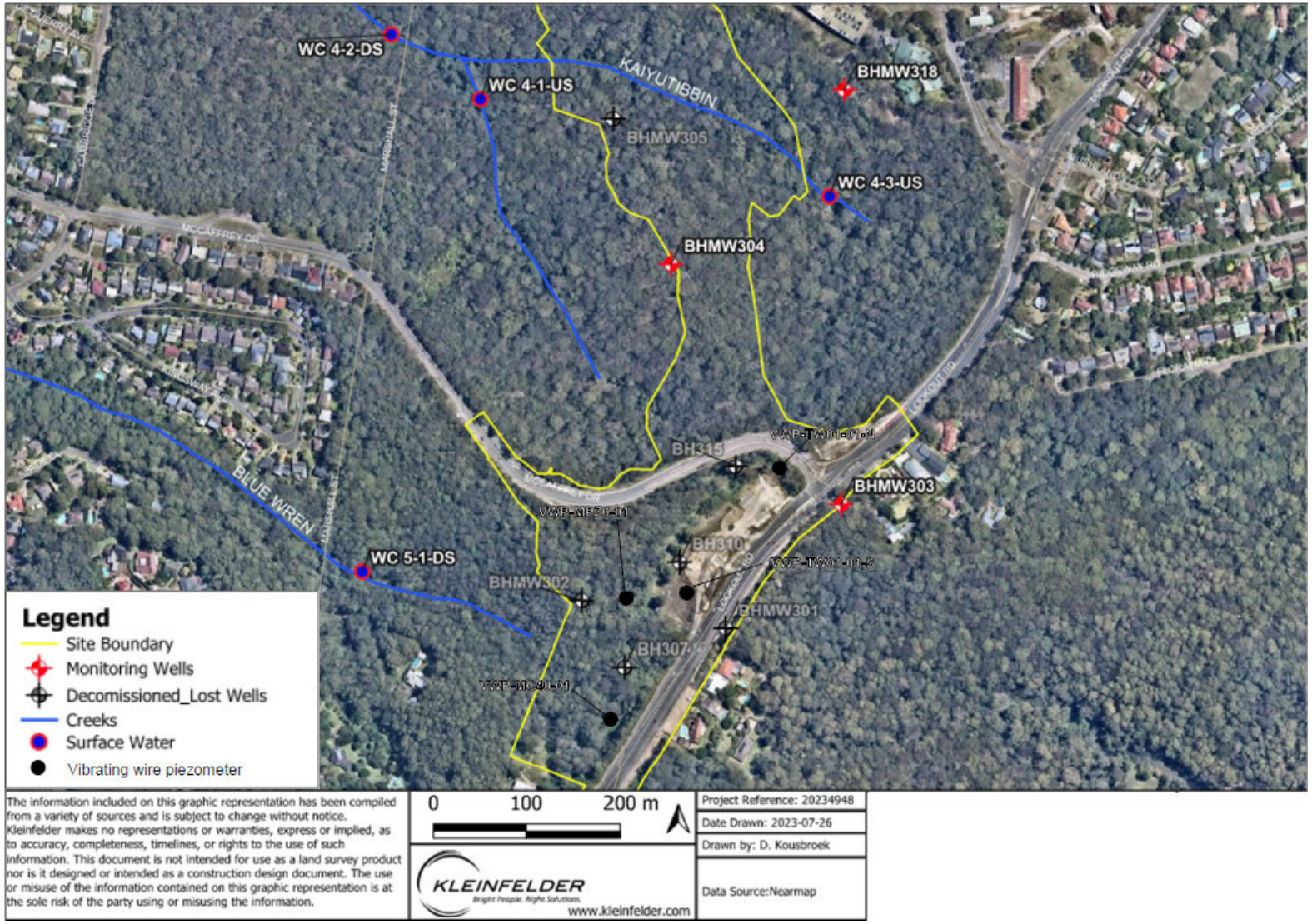


Figure A-2.1 Groundwater monitoring locations (Southern) (July 2023)

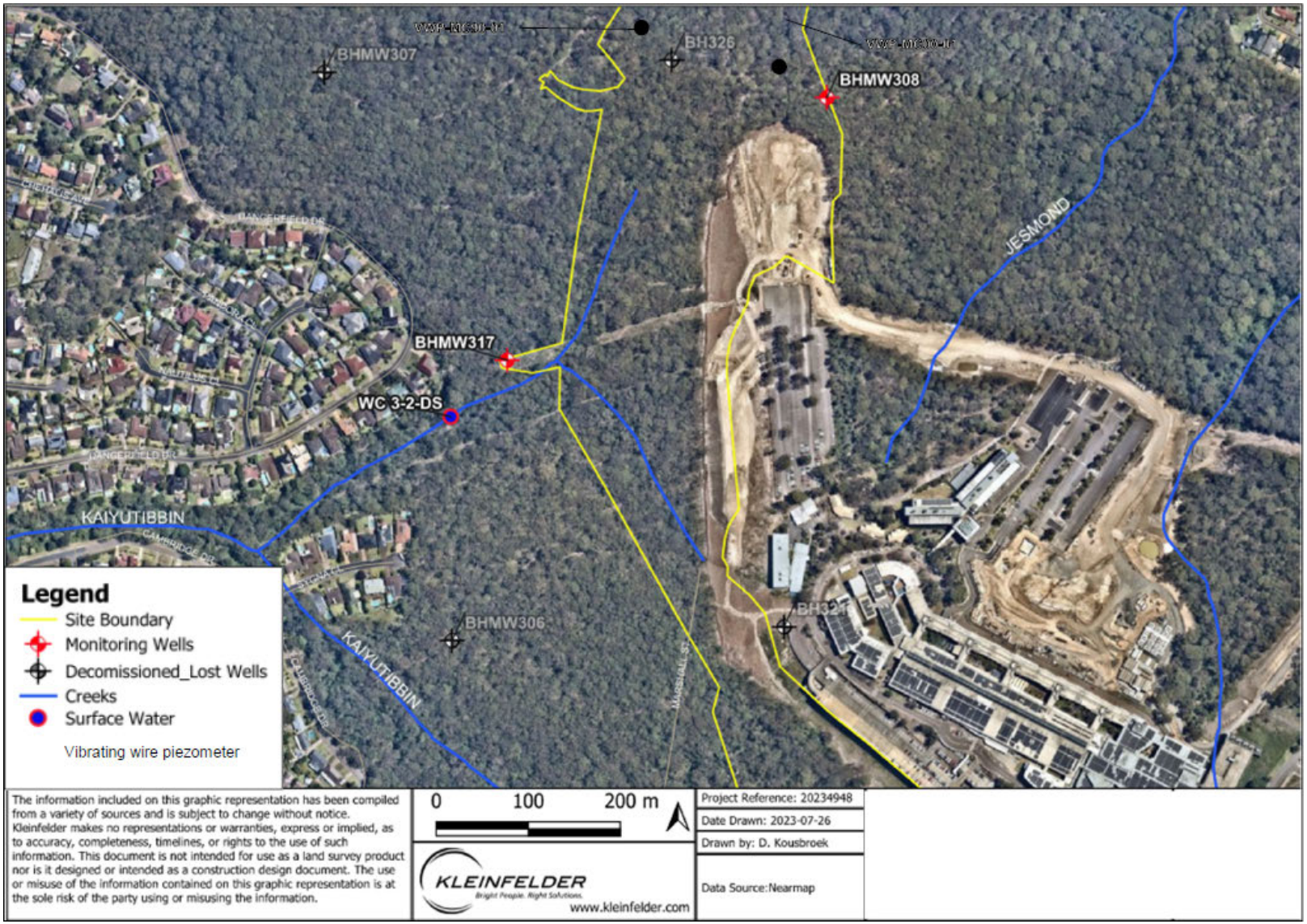


Figure A-2.2 Groundwater monitoring locations (Mainline) (July 2023)

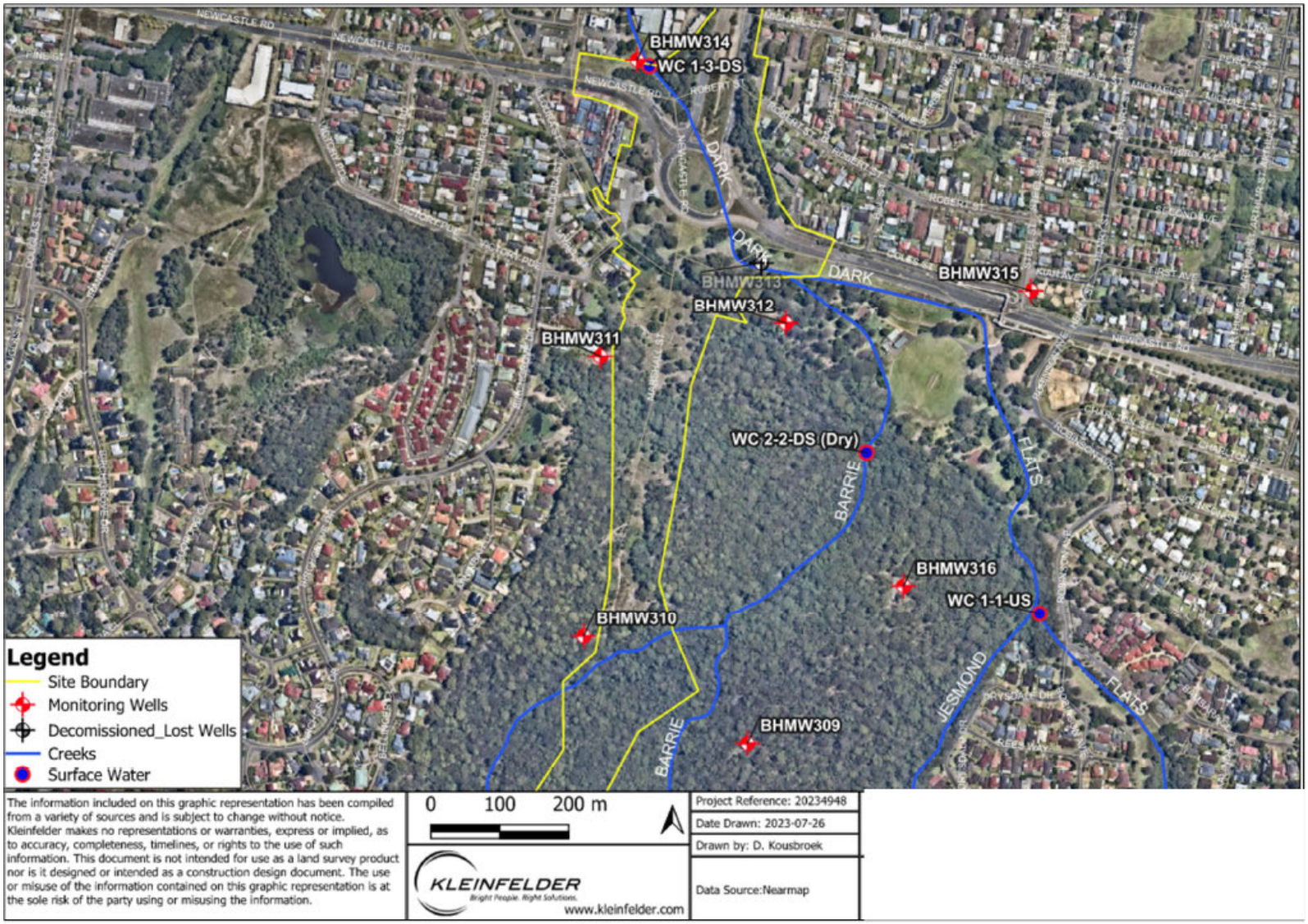


Figure A-2.3 Groundwater monitoring locations (Mainline) (July 2023)

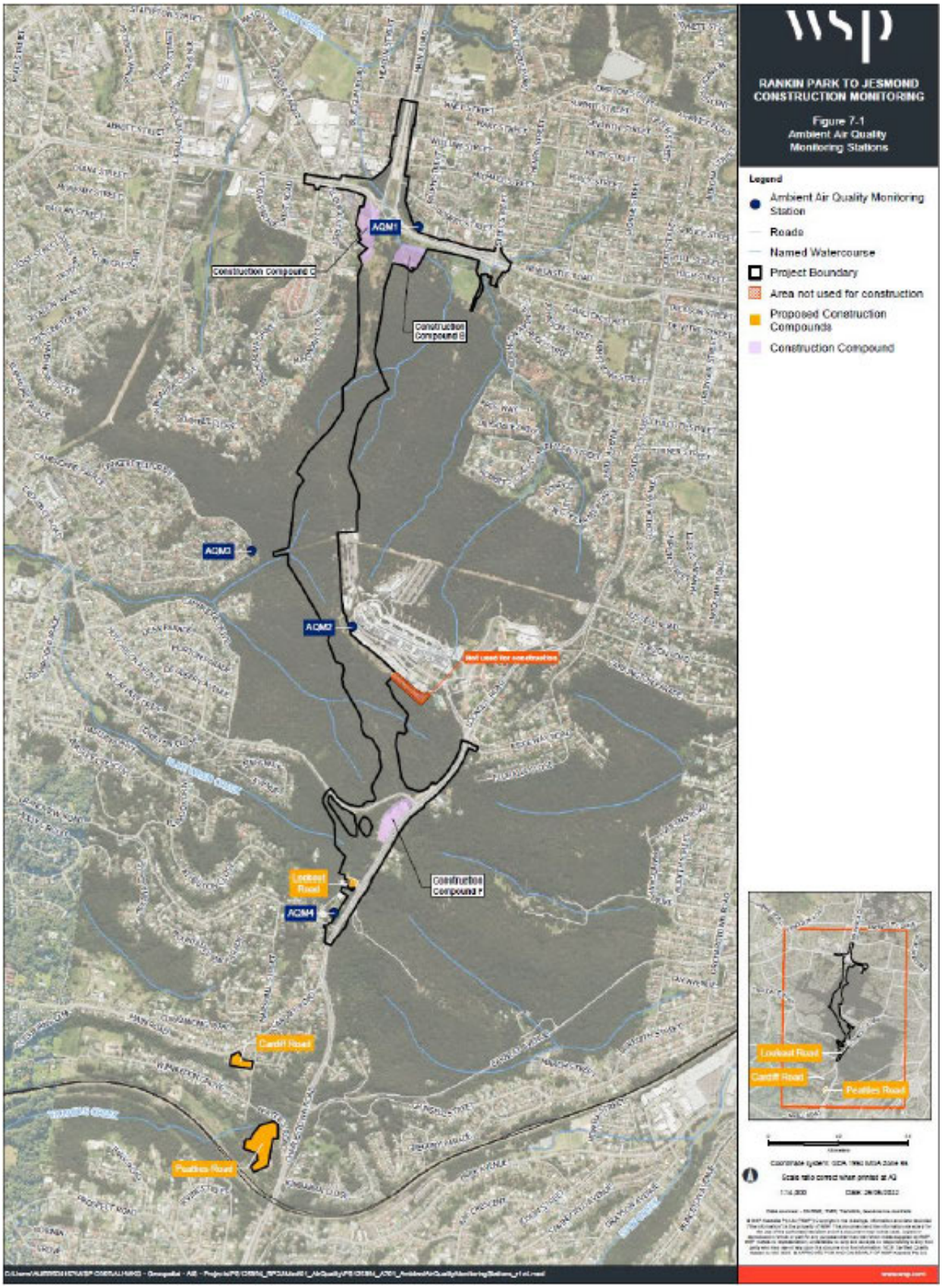


Figure A-3 Construction air quality monitoring network

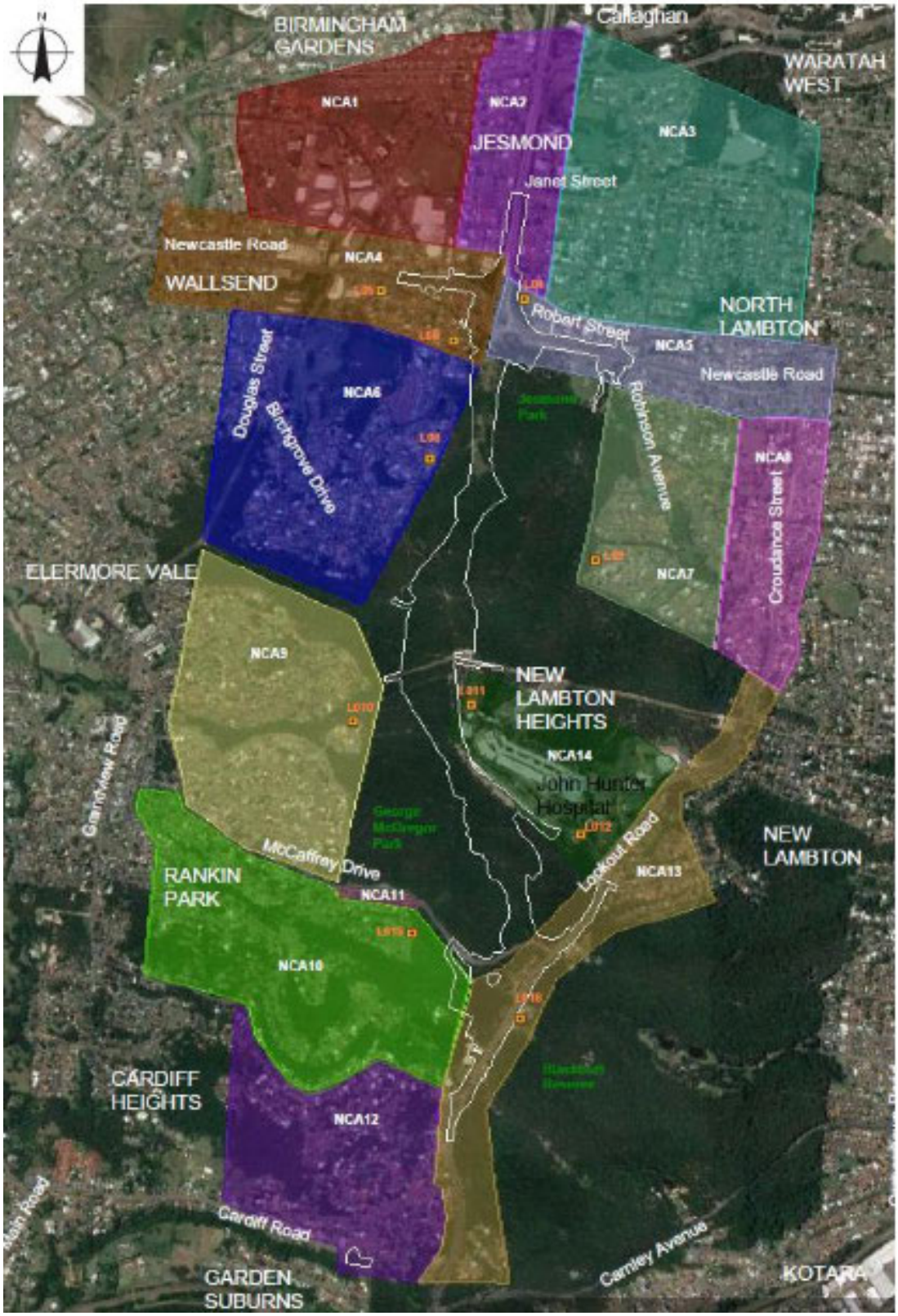


Figure A-4 Attended noise monitoring locations

Figure A- 5 Fixed noise monitoring locations at John Hunter Hospital – unattended

Unattended noise monitors (SiteHive)

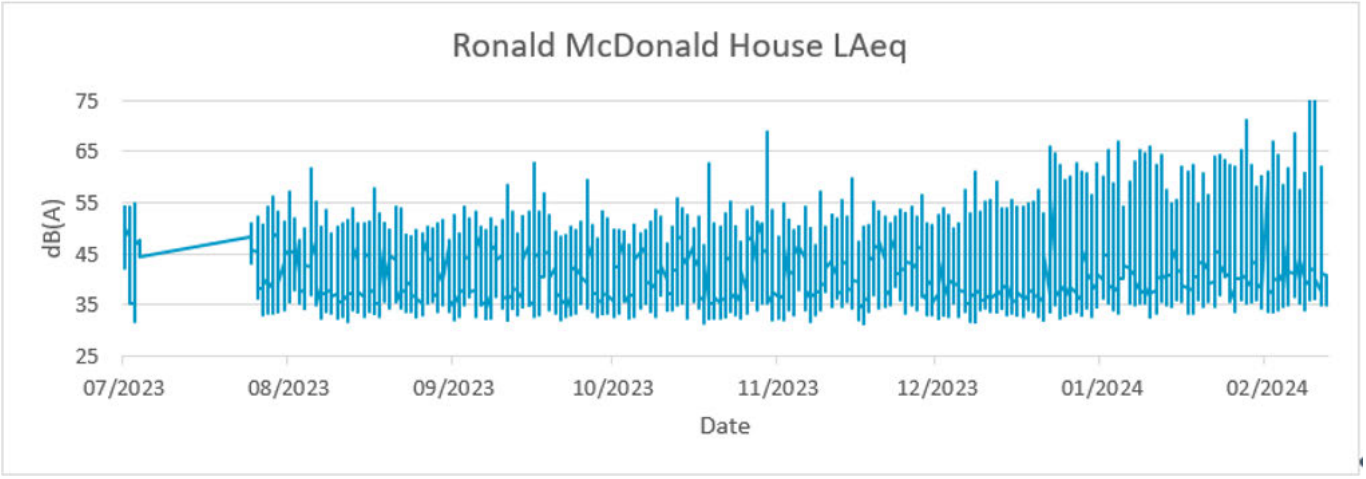


Figure A-6 Ronald McDonald House fixed noise monitoring results August 2023 to February 2024

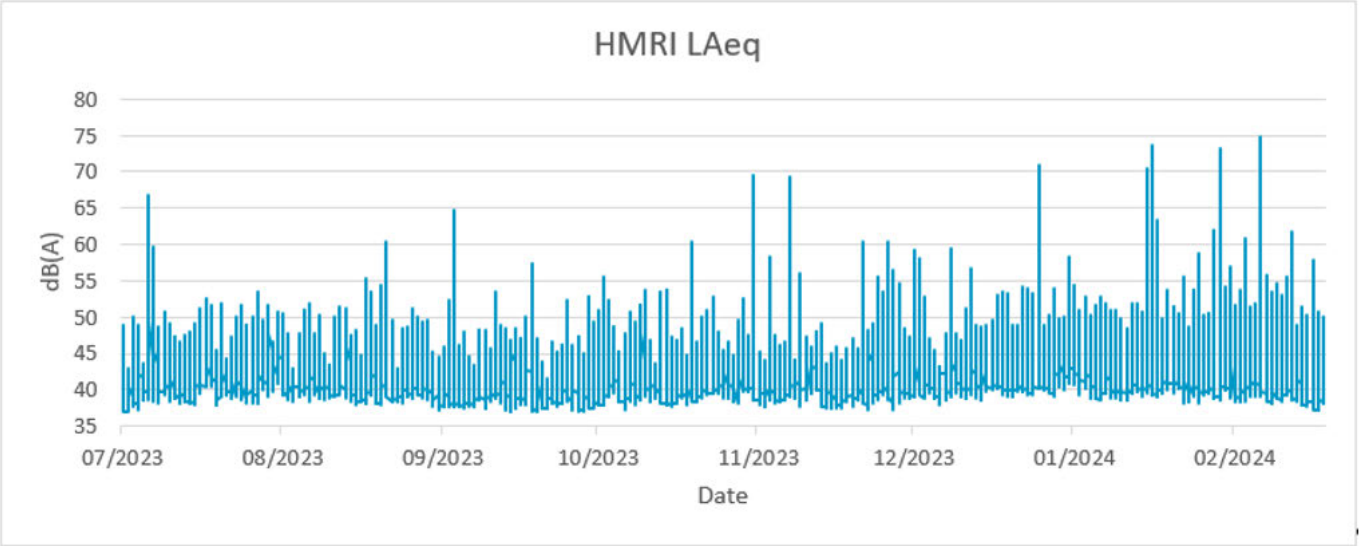


Figure A-7 HMRI fixed noise monitoring results August 2023 to February 2024

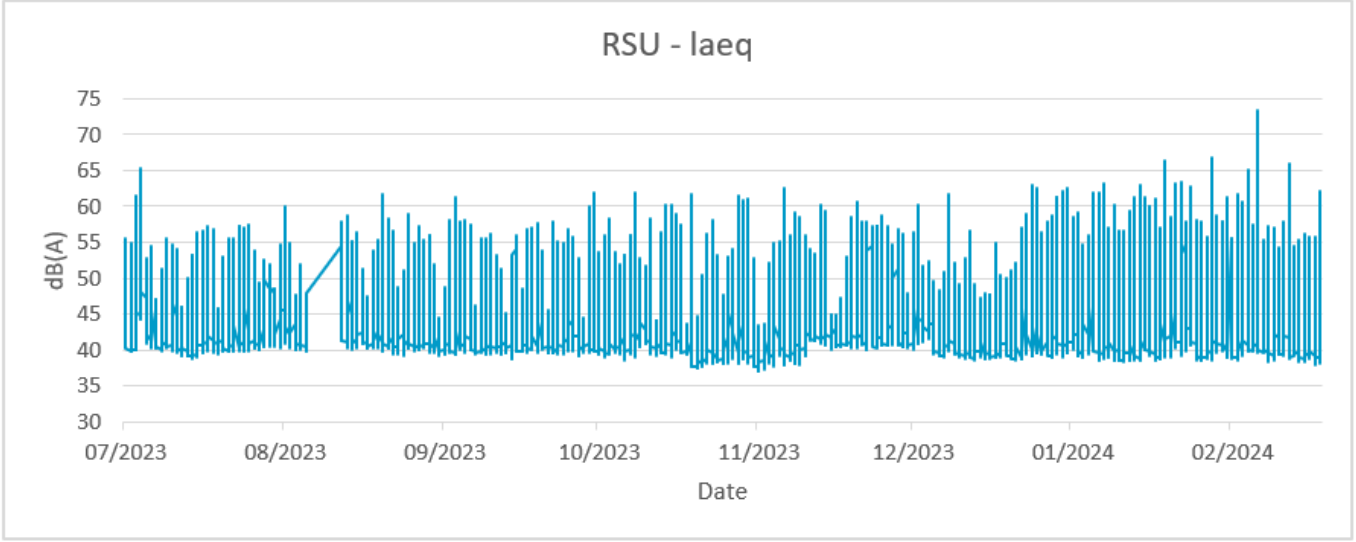


Figure A-8 RSU fixed noise monitoring results August 2023 to February 2024

Figure A-9 Background vibration monitoring locations for sensitive equipment at John Hunter Hospital – attended

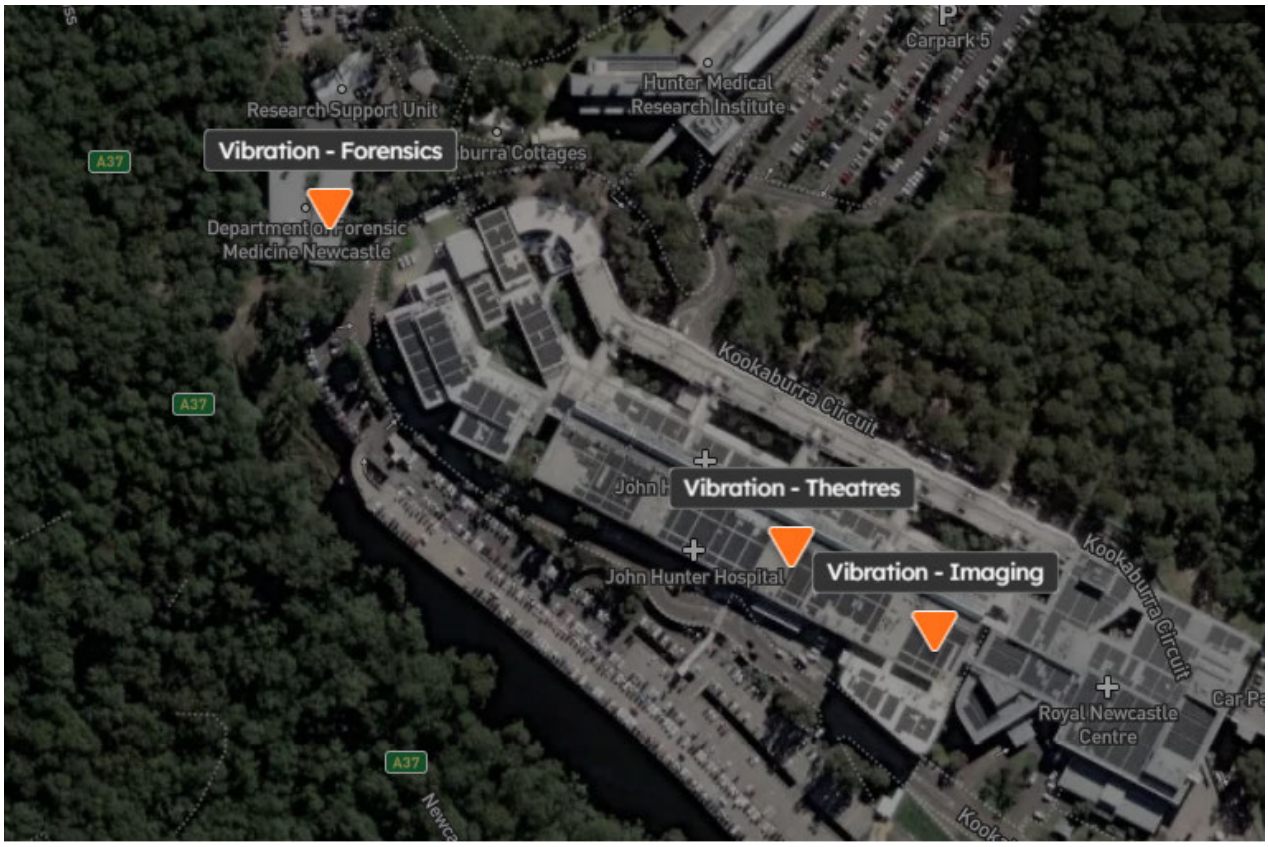


Figure A-10 Fixed vibration monitoring locations at John Hunter Hospital – unattende

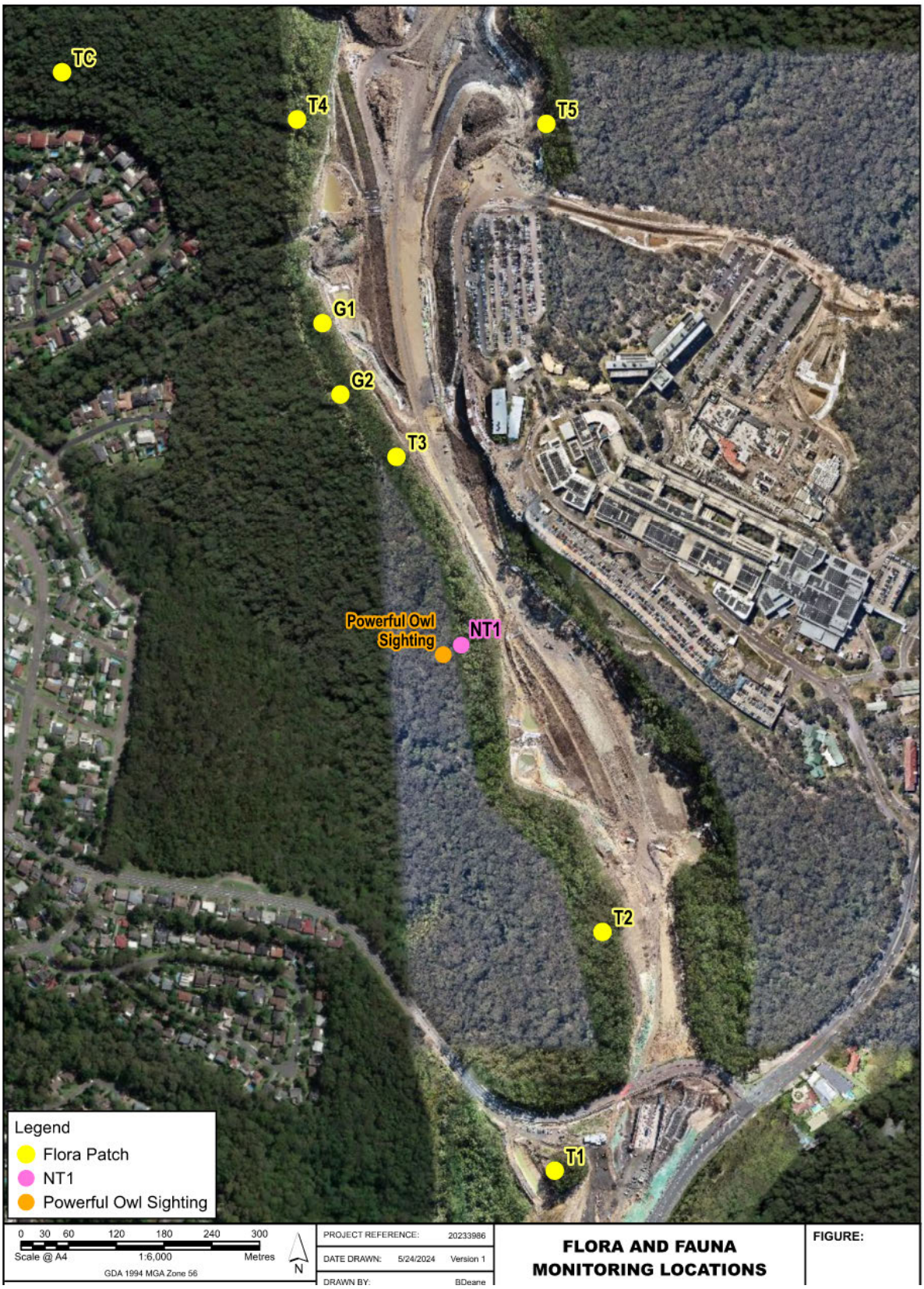


Figure A-14 Flora and fauna monitoring locations

Appendix B Surface and groundwater quality construction monitoring report

Newcastle Inner City Bypass Water Monitoring Program Annual Report

Newcastle Inner City Bypass

20234948.001A

16 July 2024

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Newcastle Inner City Bypass Water Monitoring Program Annual Report

Newcastle Inner City Bypass

Kleinfelder Project: 20234948.001A

Kleinfelder Document: NCA24R164602

Prepared for:
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Newcastle Inner City Bypass Project Site

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Prepared	Reviewed	Endorsed
		
Aaron King	Regin Orquiza	Daniel Kousbroek

EXECUTIVE SUMMARY

In March 2023, Fulton Hogan Construction Pty Ltd (Fulton Hogan) commenced construction of the Rankin Park to Jesmond Newcastle Inner City Bypass (NICB, herein referred to as the 'site') to connect the current bypass end at Jesmond roundabout on Newcastle Road, to the corner of McCaffrey Drive and Lookout Road. Kleinfelder Australia Pty Ltd (Kleinfelder) has been engaged by Fulton Hogan to undertake a water quality monitoring program as per the requirements of the Surface and Ground Water Quality Construction Monitoring Program (SGWQCMP) (TfNSW, 2022) for the site. Surface water and ground water quality monitored commenced in February 2023, prior to construction works commencing. The water quality monitoring program includes monthly surface water monitoring, quarterly groundwater monitoring, and surface water monitoring following high rainfall events of greater than 25 mm within 24 hours.

Fulton Hogan commenced construction on 6 March 2024 and is proposed to be completed by late 2025. Kleinfelder completed the scheduled monitoring works each month between February 2023 and March 2024 for the annual reporting period to satisfy the requirements laid out in the SGWQCMP. In accordance with the SGWQCMP, pre-construction monitoring was required to be completed. This monitoring was completed in February 2023 and the results are included in this report. The annual monitoring period is 6 March 2023 to 5 March 2023. 13 monthly surface water quality monitoring events and five quarterly groundwater quality monitoring events are reported during this annual monitoring report.

The aim of the water quality monitoring program was to monitor and assess the existing network of 23 (reduced to 12 as of July 2023) groundwater wells and 10 surface water locations, to fulfill the obligations of the SGWQCMP for the project.

At the commencement of the reporting period in February 2023 (pre-construction), 17 of 23 monitoring wells were monitored, six were not able to be located due to being inside a neighboring construction project, unable to be located in the surrounding bushland or locks not able to be opened. As clearing commenced on 16 March 2023 and progressed through the approved projects clearing limit, groundwater monitoring wells located within the clearing boundary were decommissioned. Twelve groundwater monitoring wells were decommissioned as of July 2023. Eleven groundwater monitoring wells remained for monitoring for the duration of construction. In consultation with a groundwater specialist, the remaining groundwater wells were deemed adequate for the construction groundwater monitoring program.

REPORTED RESULTS AND OBSERVATIONS

The sampling and analysis program was successfully completed to meet the requirements of the SGWQCMP. Analysis of the first year of sampling results are presented in **Table ES 1** below. Further details are provided in **Section 5** and **Appendix B**.

Table ES 1 – Results and Trends Summary (February 2023 – 5March 2024 Monitoring)

Analyte	Number of Reported ANZG (2018) Exceedances	Number of Reported Pre-Construction Baseline Exceedances	Reported upstream – downstream parameter exceeds by greater than 20% (surface water)	Trend and Discussion
Hydrocarbons (BTEXN, TRH)	Nil	Nil	Nil	One observation of hydrocarbon sheen was reported at WC 3-2-DS during May 2023. This was chemically analysed and reported below the laboratory limit of reporting (LOR). No other observations of oil or sheen were reported during the monitoring period.

Analyte	Number of Reported ANZG (2018) Exceedances	Number of Reported Pre-Construction Baseline Exceedances	Reported upstream – downstream parameter exceeds by greater than 20% (surface water)	Trend and Discussion
Aluminium	4 (groundwater) 25 (surface water)	11 (surface water)	2 (creek 1) 4 (creek 4)	Concentrations were reported above the ANZG (2018) criteria in groundwater and surface water and were predominantly within the range of pre-construction baseline data. Aluminium concentrations in surface water fluctuated, with higher concentrations correlating with periods of higher rainfall. These results are likely due to natural fluctuations and are attributable to the urban setting of the site.
Arsenic	Nil	33 (surface water)	1 (creek 1) Nil (creek 4)	Concentrations were reported slightly above pre-construction results at several surface water monitoring locations. Concentrations above pre-construction baseline data were minor and are likely due to natural fluctuations and are attributable to the urban setting of the site.
Boron	5 (surface water)	39 (surface water)	10 (creek 1) 2 (creek 4)	No pre-construction baseline monitoring was undertaken for boron. Baseline data has been obtained from the February 2023 monitoring event, which occurred prior to land clearing works at the site. As such, the full range of pre-construction boron concentrations is unknown and should be used as an indicative guide only. Boron concentrations reported above the ANZG (2018) criteria were reported at WC Ironbark Ck-DS and are strongly correlated with elevated electrical conductivity, indicating the presence of brackish or saline waters. These results are therefore not considered attributed to site operations.
Cadmium	1 (groundwater) 1 (surface water)	8 (surface water)	Nil	Concentrations of cadmium reported above the ANZG (2018) criteria and pre-construction baseline data were minor and are likely due to natural fluctuations and are attributable to the urban setting of the site.

Analyte	Number of Reported ANZG (2018) Exceedances	Number of Reported Pre-Construction Baseline Exceedances	Reported upstream – downstream parameter exceeds by greater than 20% (surface water)	Trend and Discussion
Chromium	Nil	Nil	Nil	No exceedances were reported during the investigation period.
Copper	19 (groundwater) 74 (surface water)	22 (surface water)	9 (creek 1) 8 (creek 4)	Concentrations of copper were reported above the ANZG (2018) criteria at all surface water and groundwater monitoring locations, with the exception of BHMW316. Concentrations were generally consistent with pre-construction results during the monitoring period. Exceedances of the pre-construction baseline data were minor and are likely due to natural fluctuations and are attributable to the urban setting of the site.
Iron	Nil	25 (surface water)	Nil (creek 1) 3 (creek 4)	Concentrations of iron were reported above pre-construction baseline data at several surface water monitoring locations. Increased iron concentrations appeared to decrease during high rainfall periods and may be reflective of the urban setting of the site or leaching of iron from exposed soils.
Lead	1 (groundwater) 1 (surface water)	3 (surface water)	Nil	Concentrations of lead were reported above the ANZG (2018) criteria at BHMW309 and WC 3-2 DS. Exceedances of the pre-construction baseline data were minor, and all lead results were stable and were below the laboratory LOR during most sampling events at all sampling locations.
Manganese	2 (groundwater)	27 (surface water)	2 (creek 1) 9 (creek 4)	Concentrations of manganese were reported above the ANZG (2018) criteria at BHMW303. Concentrations of manganese were reported above the pre-construction baseline data at several surface water monitoring locations. Similar to iron, higher manganese results appeared to correlate with sampling during high rainfall periods and may be reflective of the urban setting of the site or leaching of manganese from exposed soils.

Analyte	Number of Reported ANZG (2018) Exceedances	Number of Reported Pre-Construction Baseline Exceedances	Reported upstream – downstream parameter exceeds by greater than 20% (surface water)	Trend and Discussion
Mercury	Nil	Nil	Nil	No exceedances were reported during the investigation period. Furthermore, no detectable concentrations of mercury were reported at any monitoring locations at any time during the monitoring period.
Nickel	17 (groundwater) 1 (surface water)	9 (surface water)	12 (creek 1) 7 (creek 4)	Concentrations of nickel were reported above the ANZG (2018) criteria at all groundwater monitoring locations, with the exception of BHMW317. All nickel concentrations in groundwater were stable and below the pre-construction baseline maximum during the monitoring period. Concentrations of nickel were predominantly reported above pre-construction baseline data at WC 3-2 DS. Exceedances of the pre-construction baseline data were minor and are likely due to natural fluctuations and are attributable to the urban setting of the site. Except for one occurrence at WC 4-2-DS which exceeded ANZG (2018) criteria.
Zinc	19 (groundwater) 32 (surface water)	8 (surface water)	6 (creek 1) 6 (creek 4)	Concentrations of zinc were generally stable during the monitoring period. Exceedances of the pre-construction baseline data were minor, with the majority of exceedances occurring during periods of high rainfall. Elevated concentrations of zinc are likely due to natural fluctuations and are attributable to the urban setting of the site.

Analyte	Number of Reported ANZG (2018) Exceedances	Number of Reported Pre-Construction Baseline Exceedances	Reported upstream – downstream parameter exceeds by greater than 20% (surface water)	Trend and Discussion
Total Nitrogen	23 (groundwater) 68 (surface water)	12 (surface water)	11 (creek 1) 7 (creek 4)	Concentrations of nitrogen were variable during the monitoring period. Given the site is in an urban setting, nitrogen concentrations would be anticipated to fluctuate significantly with nutrient-laden stormwater runoff from urban environments. It is therefore possible that detected elevated nutrient concentrations are reflective of the wider environment and not of site conditions.
Phosphate (as P) (Total Phosphorus)	27 (groundwater) 39 (surface water)	4 (surface water)	6 (creek 1) 5 (creek 4)	Concentrations of phosphorus were variable during the monitoring period. Given the site setting in a heavily disturbed urban environment, phosphorus concentrations would be anticipated to fluctuate significantly with nutrient-laden stormwater runoff from urban environments. It is therefore possible that detected elevated nutrient concentrations are reflective of the wider environment and not of site conditions.
Total Suspended Solids (TSS)	Not Applicable	2 (groundwater) 25 (surface water)	6 (creek 1) 9 (creek 4)	TSS concentrations reported during the monitoring period were highly variable and were likely influenced by conditions within creek lines. Creek lines in the study area were predominantly ephemeral or low flowing, which contributed to the build-up of debris within the creek lines, increasing TSS levels of the creek lines and likely impacting on the reported results. This is evidenced by the increase in TSS following high rainfall events, with settled debris likely flushed out of the creek lines during rainfall.

Analyte	Number of Reported ANZG (2018) Exceedances	Number of Reported Pre-Construction Baseline Exceedances	Reported upstream – downstream parameter exceeds by greater than 20% (surface water)	Trend and Discussion
pH (field measurement)	5 (groundwater) 21 (surface water)	33 (surface water)	6 (creek 1) Nil (creek 4)	Concentrations of pH obtained indicate that the pH reported outside of the acceptable criteria range during monitoring events could have been influenced by local conditions within the creek lines and was unlikely to be the result of acidic or alkaline water discharged from the site.
Turbidity (field measurement)	23 (groundwater) 55 (surface water)	41 (surface water)	5 (creek 1) 12 (creek 4)	Turbidity concentrations reported during the monitoring period were highly variable and were likely influenced by conditions within creek lines. Creek lines in the study were predominantly ephemeral or low flowing, which contributed to the build-up of debris within the creek lines, increasing turbidity levels of the creek lines and likely impacting on the reported results. This is evidenced by the increase in turbidity following high rainfall events, with settled debris likely flushed out of the creek lines during rainfall.

CONCLUSIONS

- Based on a review of the results for the Kleinfelder and laboratory QA/QC program adopted, the overall data quality is considered to be suitably reliable and representative of groundwater and surface water conditions at the site.
- Following rainfall events which triggered surface water monitoring events, in October (27.6mm in 24 hours on 26 October) and November (99mm within 24hours on 5 November), numerous analyte and parameter exceedances including Cadmium, Lead, Aluminium, Zinc, turbidity and pH were reported greater than the laboratory LOR and/or the adopted criteria. This is likely reflective of runoff from the surrounding urban environment, as well as a flush-out of settled debris and sediment build-up along ephemeral creek lines.
- Overall, the majority of analytes were reported below the adopted ANZG (2018) criteria and pre-construction baseline data during the majority of sampling events. Several exceedances were reported during the monitoring period; however, these exceedances are characteristic of the urban setting and baseline water quality data of the site (including stormwater runoff from surrounding residential and commercial premises and roadways), natural seasonal fluctuation of background concentrations of contaminants, and the build-up of debris and sediments within creek lines during dry periods (which is flushed into creek lines in stormwater during rainfall events). None of the exceedances identified were able to be directly or definitively attributed to site operations.
- Furthermore, site operational controls (including (but not limited to) sediment control, waste management, and water management) were undertaken by Fulton Hogan during the monitoring period. These management controls were compliant with the sites' regulatory responsibilities (including the NSW EPA Environment Protection License (EPL) and SGWQCMP), reducing the likelihood of offsite impacts as a result of site operations.

- Kleinfelder has not determined the need for additional management responses at this time. Kleinfelder does recommend clarification regarding dissolved metals performance criteria (except for Arsenic) which are listed as total metals in the SGWQCMP.

Overall, the water quality results are relatively consistent with the summary provided in the SGWQCMP for the baseline data. Results obtained above the adopted performance criteria were primarily attributable to natural seasonal fluctuations or background concentrations for the urban setting of the site. It is unlikely that site operations have exclusively contributed to exceedances identified in this report and exceedances are likely attributable to natural seasonal fluctuations within the study area or background concentrations for the urban setting of the site.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

Kleinfelder was engaged by Fulton Hogan to conduct a water quality monitoring program at the Rankin Park to Jesmond Newcastle Inner City Bypass (NICB) project site, NSW (herein referred to as the 'site') located between the Jesmond roundabout on Newcastle Road and the Corner of McCaffrey Drive and Lookout Road. Site activities including clearing, earthworks and construction began in March 2023 and water monitoring commenced in February 2023, prior to construction commencing. The location of the site and site layout are presented in **Appendix A, Figure 1 & Figure 2**.

Monthly surface water monitoring and quarterly groundwater monitoring is required to assess potential impacts from construction activities as outlined in the Environmental Impact Statement (EIS), (GHD, 2016) and the Submissions and Preferred Infrastructure Report (SPIR) (GHD, 2018). This monitoring program has been prepared based on the recommendations of the aforementioned reports to address the requirements of the Ministers Infrastructure Approvals (SSI 6888) including the relevant the Conditions of Approval (CoA), specifically CoA's C10, C14 and C15, and other applicable guidance and legislation.

1.2 PURPOSE

The aim of the water quality monitoring program is to monitor and assess the existing network of 23 (reduced to 12 as of July 2023) groundwater wells and 10 surface water locations, to fulfill the obligations of the Surface and Groundwater Quality Construction Monitoring Program (SGWQCMP) (TfNSW, 2022) for the project. Results of the monitoring program are reported monthly and compiled annually. The annual reporting period is 6 March 2023 to 5 March 2024. Pre-construction surface and groundwater monitoring was completed in February 2023 as a requirement of the SGWQCMP. Pre-construction and the 12 months of surface and groundwater monitoring is included in this report.

2 SITE CHARACTERISATION

2.1 SITE IDENTIFICATION

Site identification details are provided below in Table 2-1.

Table 2-1 – Site Identification Details

Site address	From the corner of Newcastle Road and the Newcastle Inner City Bypass Jesmond to 110 Lookout Road New Lambton Heights
Site name	Newcastle Inner City Bypass Rankin Park to Jesmond (NICB RP2J)
Current land use	Active construction site
Surrounding land use	Primarily urban residential, bushland remnants and John Hunter hospital
Site total area	Approximately 3.4km four lane road encompassing approximately 48 hectares
Current ownership	Transport for NSW
Local government	City of Newcastle
Construction Operations	Fulton Hogan is proposed to complete the Newcastle Inner City Bypass construction by late 2025.

2.2 CURRENT SITE LAYOUT

The site is an active construction site and extends from Rankin Park to Jesmond. The site is predominantly bounded by a large patch of remnant native bushland within a predominantly developed urban landscape, which is surrounded by residential properties. The John Hunter Hospital is adjacent to the east of the site.

This site is currently within full-scale earthworks and construction phase with significant site layout changes apparent within the first year of works. Overall, the site currently consists of open bare earth with minor gravel aggregate hardstand areas for on-site office demountable buildings. Eleven sediment basins and five ephemeral creek lines exist within and in the vicinity of the site to store and control water release to the surrounding environment.

2.3 SURROUNDING LAND USE

2.3.1 Northern Portion of Site

The Northern end of the site consisting of the Jesmond roundabout and Jesmond compound area is generally surrounded by the following land uses:

- West – residential properties.
- North – local businesses of Jesmond, main road Junction (Newcastle Road and pre-existing Newcastle Bypass) and residential properties.
- East – Public parkland and bushland.

2.3.2 Mainline

Generally, through the mainline area of the site which stretches from the Jesmond roundabout to the junction of McCaffrey Drive and Lookout Road, the surrounding land is native bushland on both the east and west. The neighbouring John Hunter Hospital is also located to the east of the mainline near the centre of the site.

2.3.3 Southern Portion of Site

The south end of the site consists of the construction areas located to the south of the McCaffrey Drive and Lookout Road junctions with surrounding land use consisting of:

- West – steep slope covered in bushland with some area of cleared undergrowth.
- South – bushland, water tank and residential properties.
- East – Lookout Road with residential properties and Blackbutt bushland reserve.

2.4 HYDROLOGY AND HYDROGEOLOGY

2.4.1 Surface Water

Surface water within the project area falls within the upper Ironbark Creek catchment. Ironbark Creek is the largest tidal creek draining into the Hunter River. It flows through the Hexham Swamp, a large floodplain, before entering the Hunter River through floodgates at Sandgate. The Hexham Swamp is an estuarine wetland identified as a costal wetland under the State Environmental Planning Policy (SEPP) (Coastal Management) 2018 and is part of the Hunter Estuary Wetlands Ramsar Site.

Historically floodgates at the confluence with the Hunter River have reduced the tidal exchange and resulted in oxidation of acid sulfate soils, lowering pH in several tributaries and raising soluble iron levels in the local waterways (Newcastle City Council, 2004). Since the floodgates were raised in 2008 there has once again been tidal fluctuations evident within Ironbark creek and tidal flooding of the Hexham swamp saltwater wetlands.

2.4.2 Groundwater

The groundwater environment identified on-site by the SGWQCMP, describes two main aquifers that underly the site. A perched groundwater aquifer of low yield is identified to exist within localised and limited extents of high topography areas on site. This aquifer is not connected to other aquifers within the surrounding area and is generally separated from the regional aquifer via an aquitard made of layers of lower permeability earth. Primary discharge from this aquifer is through seepage zones into nearby watercourse, with seepage discharge proportional to the volume of rainfall infiltrating the perched aquifer, thereby exhibiting reduced seepage during dry periods. High elevation monitoring locations associated with the perched groundwater aquifer are likely to be subject to complete drying in some areas during low rainfall periods with historical monitoring indicating that groundwater elevations can vary by up to 2.6 metres.

The secondary deeper regional groundwater aquifer within the Permian Newcastle Coal Measures which underlies the site. This aquifer is predominantly recharged from areas where the strata of the lower Newcastle Coal Measures outcrop to the north of the site rather than from the overlying perched groundwater. The Permian Newcastle Coal Measures primarily consist of coals, tuffs, conglomerates, sandstones and shales.

In general, the groundwater elevation follows the variable topography of the site. Monitoring results indicated that the hydrogeological response to rainfall is variable from no change or immediate fluctuations to a delayed response.

3 MONITORING REPORT

3.1 PRE-CONSTRUCTION MONITORING RESULTS

A pre-construction monitoring program was undertaken on-site by Aurecon and Transport for NSW to understand natural surface and groundwater conditions on the site. Groundwater gauging began in September 2018, with analytical sampling results available from as early as March 2019. Surface water sampling began in December 2019 for field parameters, with analytical sampling results available from February 2020. The analytical results indicated that a number of analytes presented concentrations in exceedance of the ANZG default guidelines indicating background concentrations relating to natural seasonal fluctuations or influences of off-site sources due to the urban setting of the site.

The urban setting of the site presents the likelihood that off-site contaminate sources are having an adverse impact upon the analytical results prior to the start of construction by Fulton Hogan and continued impacts whilst construction is underway.

Pre-construction monitoring data indicated that surface water and groundwater quality parameters often exceed the default water quality criteria trigger values for slightly to moderately disturbed ecosystems. This is considered likely due to the locality of the site within a heavily modified urban environment. Location specific pre-construction maximum concentrations for all analytes have been utilized to understand changes in surface water over the course of the construction water quality monitoring program. Pre-construction ranges are outlined for all locations in **Table 3-1** and **Table 3-2** below.

Table 3-1: Pre-construction Field Parameter Ranges

Criteria	Turbidity (NTU)	Temp (^{0}C)	DO (%)	EC (µS/cm)	TDS (mg/L)	pH	Redox (mV)
WC 1-1-US Historical range*	5.5 – 87.2	10.5 - 21.9	5.2 - 95.8	119 - 470	---	6.6 – 7.94	---
WC 1-3-DS Historical range*	1.2 - 41.5	11.9 - 26.5	98.3 - 135.3	166 – 1290	---	6.91 – 8.79	---
WC 2-2-DS Historical range*	No Sample						
WC 3-2-DS Historical range*	77.5 - 268.1	6.8 - 22.2	78.4 - 99.8	66 – 974	---	6.16 – 7.77	---
WC 4-1-US Historical range*	1 - 50.9	9.1 - 21.6	72 - 96.9	129 – 283	---	6.11 – 8.30	---
WC 4-2-DS Historical range*	5.6 – 81.6	9.1 - 21.6	11.5 - 95.9	150 – 382.6	---	6.38 – 8.07	---
WC 4-3-US Historical range*	4.4 – 58.6	10.3 - 21.5	11.1 - 93.8	176 – 936	---	6.52 – 7.96	---
WC 5-1-DS Historical range*	10.28 – 62.3	19.1 - 21.1	48.6 - 64.8	232 – 769	---	5.94 – 6.06	---
WC Blue Wren Ck-DS Historical range*	3.5 – 72	9.7 - 22.6	10.4 - 99.7	170 – 818	---	6.50 – 7.57	---
WC Ironbark Ck-DS Historical range*	9.6 – 79.4	10.3 - 25.9	22.3 - 110.9	240 - 28484	---	6.63 – 7.74	---

Table 3-2: Pre-construction Analytical Parameter Ranges

Analyte	Metals												Inorganics		
	Aluminium	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc	Total Nitrogen	Total Phosphorous	TSS
LOR	0.05	0.001	0.05	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.005	0.001	0.1	0.01	5.0
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
WC 1-1-US Historical concentration*	0.14	<LOR	<LOR	<LOR	0.002	0.005	0.48	0.001	0.088	<LOR	0.002	0.037	1.48	0.28	91
WC 1-3-DS Historical concentration*	0.14	<LOR	<LOR	<LOR	0.002	0.004	0.29	<LOR	0.033	<LOR	0.011	0.059	3.8	0.6	130
WC 2-2-DS Historical concentration*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
WC 3-2-DS Historical concentration*	1	<LOR	<LOR	<LOR	0.003	0.004	0.66	0.001	0.026	<LOR	0.002	0.025	1.7	0.17	130
WC 4-1-US Historical concentration*	0.2	<LOR	<LOR	<LOR	0.001	0.001	1.6	<LOR	0.15	<LOR	0.002	0.011	1.7	0.14	14
WC 4-2-DS Historical concentration*	0.4	<LOR	<LOR	<LOR	0.002	0.002	1.14	<LOR	0.231	<LOR	0.003	0.036	1.6	0.1	12
WC 4-3-US Historical concentration*	0.42	<LOR	<LOR	<LOR	0.003	0.002	0.79	<LOR	0.438	<LOR	0.002	0.015	1.8	0.81	26
WC 5-1-DS Historical concentration*	0.29	<LOR	0.007	<LOR	0.002	0.003	0.23	0.001	0.026	<LOR	0.001	0.033	1.7	0.02	<LOR
WC Blue Wren Ck-DS Historical concentration*	0.11	0.002	0.06	<LOR	0.002	0.004	2.3	0.002	0.36	<LOR	0.001	0.098	3.3	0.21	16
WC Ironbark Ck-DS Historical concentration*	0.09	0.001	0.08	0.0002	0.002	0.004	0.93	0.001	1	<LOR	0.007	0.067	2.7	0.34	28

3.2 Surface and Ground Water Quality Construction Monitoring Program (SGWQCMP)

Reporting requirements associated with the Monitoring Program for the construction phase of the Project are presented in **Table 3-3**.

Table 3-3: Surface and groundwater quality monitoring requirements

Sampling Location	Frequency
Surface water sampling	Monthly and wet weather[1]
Sediment basin sampling	Prior to discharge as per the Project EPL
Groundwater data loggers and elevation	Quarterly
Groundwater sampling	Quarterly
Groundwater sampling post significant spill event	Should a significant spill incident occur, additional groundwater wells would be considered to be installed at that juncture if significant risks to groundwater quality were identified (which would likely trigger additional surface water monitoring locations).

[1] Following 25 mm of continuous rainfall within a 24-hour period

At the commencement of the reporting period in February 2023 (pre-construction), 17 of 23 monitoring wells were located and deemed accessible for monitoring. The remaining six were not able to be located due to being inside of a neighbouring construction project or unable to be located in the surrounding bushland or locks not able to be opened. As clearing commenced on 16 March 2023 and progressed through the approved projects clearing limit, groundwater monitoring wells located within the clearing boundary were decommissioned. Twelve groundwater monitoring wells were decommissioned as of July 2023. Eleven groundwater monitoring wells remained for monitoring for the duration of construction. In consultation with a hydrogeologist, the remaining groundwater wells were deemed adequate for the construction groundwater monitoring program.

In the reporting period, five groundwater sampling and six groundwater gauging events occurred, including one month prior to construction, commencing in February 2023.

Ten surface water locations have been monitored monthly throughout the reporting period, including one month prior to construction. In the reporting period, 17 monitoring events were completed, 13 being monthly and four high rainfall sampling events triggered by >25mm of rainfall recorded within 24 hours undertaken. Monitoring locations are presented in **Appendix A, Figure 1-4.**

3.2.1 Monitoring

Each monitoring event included the collection of samples for laboratory analysis of the following:

- 12 Dissolved metals – Aluminium (Al), Arsenic (As), Boron (B), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Zinc (Zn)
- Nutrients – Total Nitrogen (TN) and Total Phosphate (TP) and,
- Total Suspended Solids (TSS).

Note that hydrocarbons (Total Recoverable Hydrocarbons (TRH), Benzene, Toluene, Ethylbenzene, Xylene and Naphthalene (BTEXN) (Silica gel clean-up)) were only analysed after a known spill had occurred, or hydrocarbon sheen/odour was identified by field observations during site works.

3.2.1.1 Monthly Surface Water Quality Monitoring and High Rainfall Event Monitoring

The monthly and high rainfall event (>25 mm in 24hours) surface water monitoring scope of works included the sampling of ten surface water locations for laboratory analysis outlined above. During sampling, field observations (sheen, odour, colour, flow, algae, etc.) and field parameters (pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), reduction/oxidation potential (redox), temperature, and turbidity) were recorded.

3.2.1.2 Quarterly Groundwater Quality Monitoring

Quarterly groundwater quality monitoring was undertaken in February, May, August and November 2023. Groundwater monitoring included the gauging and sampling of all available monitoring wells. During sampling, field observations (sheen, odour, colour, recharge, etc.) and field parameters (pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), reduction/oxidation potential (redox), temperature, and turbidity) were recorded. A total of 23 initial groundwater well locations were provided, of which the following number of groundwater wells were located and accessed during each event. **Table 3-4** below, provides the number of groundwater monitoring wells that were gauged and sampled during this annual period from February 2023 to February 2024. It is noted that, the majority of groundwater wells were found to contain sufficient water for sampling during most events. Where a monitoring well was accessed and gauged without sampling, this was due to the groundwater wells being dry or containing insufficient water for sample retrieval.

Table 3-4 – Summary of Gauged and Sampled Groundwater Monitoring Wells

Month	Gauged	Sampled
February 2023	18*	12*
March 2023	15*	0
April 2023	13	0
May 2023	12	7
August 2023	12	8
November 2023	12	8
February 2024	12	7

Notes: * two additional locations were gauged and sampled during March 2023 as they became accessible

3.2.2 Monitoring Location Observations

A summary of general monitoring observations is provided in **Table 3-5** below. Locations of wells and sampling points are illustrated on **Figures 1-4** in **Appendix A.**

Table 3-5: Summary of Groundwater and Surface Water Monitoring Location Observations

Well ID / Sample Location ID	Status	General Observations
BHMW301	Unable to be found at start of construction.	Decommissioned. No samples taken.
BHMW302	Dry, Decommissioned	Standpipe, root inundation, standpipe in good condition, decommissioned March 2023
BHMW303	Insufficient water	Cloudy brown/grey, low sulphur odour, no sheen standpipe in good condition
BHMW304	Dry	Root inundation, standpipe in good condition
BHMW305	Good, sampled February – April 2023, Decommissioned	Brown, no odour, no sheen, standpipe in good condition, decommissioned May 2023
BHMW306	Unable to be found at start of construction.	No samples taken
BHMW307	Unable to be found at start of construction.	No samples taken
BHMW308	Good, insufficient water	Brown, no odour, no sheen, gatic with water in cavity and dented pvc
BHMW309	Good, insufficient water	Cloudy grey, no odour, no sheen, gatic in good condition
BHMW310	Dry	Gatic in good condition

Well ID / Sample Location ID	Status	General Observations
BHMW311	Dry	Standpipe good condition
BHMW312	Good	Clear, no odour, no sheen, standpipe in good condition
BHMW313	Good, sampled February 2023, Inaccessible, Decommissioned	Clear, no odour, no sheen, gatic in good condition, inaccessible March – May 2023, Decommissioned August 2023
BHMW314	Good	Light brown, no odour, no sheen, gatic cover rusted
BHMW315	Good	Light yellow no odour, no sheen, gatic in good condition
BHMW316	Good	Clear, moderate Sulphur odour, no sheen, damaged standpipe
BHMW317	Good	Clear with black sediment, low Sulphur odour, no sheen, standpipe in good condition
BHMW318	Good	Brown, no odour, no sheen, standpipe in good condition
BH307	Good, Sampled February and March 2023, Decommissioned	Brown, no odour, no sheen standpipe in good condition, Decommissioned April 2023
BH310	Good, Sampled February2023, Decommissioned	Light brown, no odour, no sheen, standpipe in good condition, Decommissioned March 2023
BH315	Decommissioned, insufficient water	Standpipe in good condition
BH321	Good, sampled March 2023, Decommissioned	Standpipe in good condition, Decommissioned April 2023
BH326	Dry, Good, sampled March 2023, Decommissioned	Standpipe in good condition, decommissioned April 2023
WC 1-1-US	Shallow flowing disturbed natural creek	Clear, low sulphur odour, no sheen, orange/brown algae
WC 1-3-DS	Shallow flowing in concrete culvert	Clear, low to no odour, no sheen
WC 2-2-DS	Stagnant or dry pond in natural land depression	Dry
WC 3-2-DS	Shallow to dry natural rock creek bed	Brown, no odour, no sheen
WC 4-1-US	Moderately deep natural creek in bushland	Clear, no odour, minor biofilm
WC 4-2-DS	Moderately deep natural creek in bushland	Clear, no odour, no sheen
WC 4-3-US	Shallow to dry rock creek in bushland	Clear, no odour, biofilm, orange/brown algae
WC 5-1-DS	Shallow to dry natural creek in bushland	Clear, no odour, no sheen
WC Blue Wren Ck-DS	Moderate to shallow rocky creek in urban area	Clear, no odour, biofilm
WC Ironbark Ck-DS	Deep disturbed tidal watercourse	Brown tannins to clear, no odour, no sheen, high salinity

3.3 SITE INVESTIGATION LEVELS

The SGWQCMP outlines that the ANZG 2018 default guidelines will be used for comparison with water quality data collected on site. Where the results are found to exceed the chosen ANZG criteria they will be compared against the pre-construction range of analytical results to ascertain whether there has been an abnormal change to concentrations outside of previously observed fluctuation ranges.

To assist with meaningful comparisons of construction water quality a comparison has been drawn between upstream and associated downstream location data. Where a downstream parameter exceeds the corresponding upstream parameter by greater than 20% during a single monitoring event an investigation may be triggered.

Table 3-6 – Site Investigation Levels

Parameter	Investigation Level
Turbidity	6-50 NTU
Electrical Conductivity (EC)	2200 uS/cm
Dissolved oxygen (DO)	85-110
pH	6.0-8.0 pH
Total Nitrogen (TN)	0.5
Total Phosphorous (TP)	0.05
Aluminium (Al)	0.08
Arsenic (As)	0.042
Boron (B)	0.68
Cadmium (Cd)	0.0004
Chromium (Cr)	0.006
Copper (Cu)	0.0018
Lead (Pb)	0.0056
Manganese (Mn)	2.5
Mercury (Hg)	0.0019
Nickel (Ni)	0.013
Zinc (Zn)	0.015
Benzene	1.3
Toluene	0.23
Ethylbenzene	0.11
o-xylene	0.47

Notes: Units are mg/L unless indicated otherwise

As per the SGWQCMP, in the event that one or more of the triggers are exceeded, a review will be conducted by Fulton Hogan, against the performance criteria values, and against results from surrounding locations to determine the possible cause of the exceedance and significance of the exceedance. Fulton Hogan investigated exceedances to determine whether implementation of additional management measures is required.

4 MONITORING SUMMARY

4.1 SAMPLING PLAN

Monthly, quarterly, and high rainfall event monitoring was undertaken throughout the 12-month period and reported monthly. Each surface water location was accessed and sampled directly into laboratory supplied sample containers using a nitrile gloved hand or via the use of a telescopic sampling pole, where necessary, due to safety. The schedule of conducted works is noted in **Table 4-1** below.

Table 4-1: Summary of Water Quality Monitoring Event Dates and Total Samples Collected

Month	Monthly Surface Water Event Date	High Rainfall (>25mm in 24hour) Event Date	Quarterly Groundwater Event Date	Total Number of Primary Samples Collected
February 2023	24 Feb 2023	-	23 & 27 Feb	21
March 2023	28 Mar 2023	-	29 Mar[1]	11
April 2023	21 Apr 2023	-	-	9
May 2023	19 May 2023	-	17 May	16
June 2023	30 Jun 2023	-	-	7
July 2023	26 Jul 2023	-	-	8
August 2023	25 Aug 2023	8 Aug	24 Aug	25
September 2023	28 Sep 2023	-	-	6
October 2023	25 Oct 2023	27 Oct	-	14
November 2023	16 Nov 2023	6 Nov	17 Nov	28
December 2023	18 Dec 2023	-	-	6
January 2024	17 Jan 2024	-	-	6
February 2024	13 Feb 2024	15 Feb 2024	12 Feb 2024	21

Notes: [1] denotes two groundwater locations became available to access in March as part of the February quarterly monitoring

4.1.1 Quarterly groundwater quality monitoring events were undertaken in February, May, August, and November 2023 and February 2024 Groundwater

Groundwater monitoring wells were gauged for depth to water, presence of Light Non-Aqueous Phase Liquids (LNAPL) and total depth using an oil/water interface probe (IP). Groundwater samples were collected from the monitoring wells using the Low Flow micro purge pump sampling methodology. Following gauging sampling methodology consisted of, placing a low flow micropurge pump into each monitoring well, ensuring the inlet was at least 1 metre below the air/water interface. Groundwater was then purged through a water quality meter flow cell until the groundwater parameters (pH, DO, EC, temperature and redox) stabilised as per the Kleinfelder SOP-003 (Groundwater Sampling – Low Flow). Results were recorded on the field sheets and provided in each monthly report. Drawdown of water within the well did not exceed 10 cm as per the SOP. Following stabilisation of groundwater parameters, samples were collected into laboratory supplied containers and placed in an ice chilled esky. Dedicated groundwater sampling equipment and bottles were handled using disposable nitrile gloves changed prior to the collection of each sample.

Samples were filtered in the field using a 0.45 micrometre (µm) filter for dissolved metals analysis. The samples were then submitted to a NATA accredited laboratory under a chain of custody for the analytical schedule which is included as part of each monthly report and presented in **Appendix D.**

4.2 FIELD OBSERVATIONS

4.2.1 General

Construction activities began on 6 March 2023 with the clearing phase of works, beginning from both the southern interchange and northern interchange ends. Major clearing was completed by August 2023, with earthworks commencing following clearing. As of January 2024, earthworks is continuing with construction areas on site becoming more numerous.

4.2.2 Geochemical Parameters

Geochemical parameters and gauging data were recorded during the monitoring period and are presented in **Appendix B, Tables 5 & 6.** A summary of pH, Electrical Conductivity and Turbidity maximum and minimum values are summarised in **Table 4-2** below.

Table 4-2: Geochemical parameters (maximum and minimum values) Feb 2023– Feb 2024

Monitoring Location	EC (µs/cm)		Turbidity (NTU)		pH	
	Min	Max	Min	Max	Min	Max
Groundwater						
BHMW303	3462	3499	354.31	783.3	5.32	5.68
BHMW305	-	1533	-	44	-	6.02
BHMW308	82.2	1036	598.51	1427	6.77	7.25
BHMW309	667	1584	1574.2	3229.7	5.69	6.87
BHMW312	5792	7588	18	264.87	6.60	7.56
BHMW313	-	7593	-	200	-	7.22
BHMW314	10479	13145	2.5	284	6.39	7.10
BHMW315	610	807	5.55	143	6.03	6.75
BHMW316	2745	4290	4	49	6.11	6.88
BHMW317	1183	1617	3.42	477.16	6.83	7.16
BHMW318	1030	1967	353.5	6301.43	6.11	7.00
BH307	-	2862	-	2417.4	-	4.34
BH310	-	1331	-	243	-	5.75
BH321	-	1450	-	3.2	-	5.98
Surface Water (Monthly Events)						
WC 1-1-US	161.8	625	0.84	151	6.73	7.60
WC 1-3-DS	219.2	1187	2.69	1471.17	7.24	9.91
WC 2-2-DS	-	190	-	962	6.70	6.70
WC 3-2-DS	191.9	974	16	1005.6	5.29	7.58
WC 4-1-US	143.2	297.5	0	50.85	6.17	8.16
WC 4-2-DS	133.1	571	3.54	241	6.46	7.39
WC 4-3-US	363.3	845	2.88	24.8	5.73	7.23
WC 5-1-DS	475.9	769	4	96.73	5.95	6.69

Monitoring Location	EC (µs/cm)		Turbidity (NTU)		pH	
	Min	Max	Min	Max	Min	Max
WC BlueWren Ck-DS	206.5	818	0.2	41.17	6.44	7.98
WC Ironbark Ck-DS	531	52064	4.1	132.45	6.50	7.52
Surface Water (High Rainfall Events)						
WC 1-1-US	220	292	30.9	117.14	6.60	7.60
WC 1-3-DS	250	404.9	52.9	321	6.60	8.94
WC 2-2-DS	-	137.7	-	1950	5.90	5.90
WC 3-2-DS	260	528	484	1000	5.20	6.48
WC 4-1-US	169	250	5.37	900	6.00	7.10
WC 4-2-DS	273.5	362.6	56.43	345	6.10	6.90
WC 4-3-US	313	741	2.3	68.8	6.00	6.70
WC 5-1-DS	525	722	6.15	59	5.73	6.60
WC BlueWren Ck-DS	170	438	24.2	525.67	5.90	7.40
WC Ironbark Ck-DS	381.5	7665	7.89	208.16	7.20	7.52

Note: - only one data point available, value allocated as max

4.2.3 Summary of Results

The analytical data is summarised in **Appendix B**, along with a comparison against trigger values. Pre-construction levels are outlined in **Section 3.1**. Trend graphs are also provided in **Appendix C**. **Table 4-3** below provides a summary of groundwater and surface water concentrations as a range (minimum to maximum) for all analytes across the site and notes locations which exceeded both ANZG (2018) default guidelines and pre-construction historical results.

Table 4-3: Summary of groundwater and surface water concentration range

Analyte	Units	LOR	ANZG (2018) criteria	Detected Concentration Range (Groundwater)	Detected Concentration Range (Surface Water)	Total primary samples taken	Number of samples that exceeded ANZG criteria	Exceedances above Pre-construction and ANZG criteria
Aluminium	mg/L	0.05	0.08	<0.05-0.58	<0.05 - 2.0	178	31 (8 during rainfall events)	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 3-2-DS April (1.37 mg/L), November rainfall event (2.0 mg/L) ▪ WC 4-1-US March (0.24 mg/L), April (0.26 mg/L), November rainfall event (0.23 mg/L) and February (0.42 mg/L)
Arsenic	mg/L	0.001	0.042	<0.001-0.025	<0.001 - 0.004	178	0	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria.
Boron	mg/L	0.05	0.68	<0.05-0.21	<0.05 - 2.9	178	7	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC Ironbark Ck-DS – June (1.7 mg/L), August (0.95 mg/L), October (0.73 mg/L), November monthly event (1.2mg/L), December (2.9 mg/L), January 2024 (2.1 mg/L) and February 2024 (1.4 mg/L)
Cadmium	mg/L	0.0002	0.0004	<0.0002-0.0004	<0.0002 - 0.0007	178	2	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 3-2-DS – November monthly event (0.0007 mg/L)
Chromium	mg/L	0.001	0.006	<0.001-0.002	<0.001 - 0.002	178	0	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria

Analyte	Units	LOR	ANZG (2018) criteria	Detected Concentration Range (Groundwater)	Detected Concentration Range (Surface Water)	Total primary samples taken	Number of samples that exceeded ANZG criteria	Exceedances above Pre-construction and ANZG criteria
Copper	mg/L	0.001	0.0018	<0.001-0.007	<0.001 - 0.009	178	105 (28 during rainfall events)	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 1-3-US – March (0.005 mg/L), September (0.007mg/L), November monthly and rainfall events (0.005 mg/L) February 2024 rainfall and monthly (0.006 and 0.007 mg/L) ▪ WC 3-2-DS – May (0.007 mg/L), November (0.009 mg/L rainfall and 0.006mg/L monthly) and February 2024 rainfall (0.005 mg/L) ▪ WC 4-1-US – March (0.002 mg/L), May (0.004 mg/L), July (0.004mg/L), September (0.004 mg/L) and February rainfall 2024 (0.006 mg/L) ▪ WC4-2-DS – March (0.004 mg/L), May (0.005 mg/L), August (0.004 rainfall and 0.005 mg/L monthly), September (0.005mg/L), December (0.004 mg/L) and February 2024 rainfall (0.005 mg/L) ▪ WC4-3-US – March (0.003 mg/L), July (0.003 mg/L), October rainfall event (0.004mg/L), November (0.005 mg/L rainfall and 0.003 mg/L monthly) ▪ WC 5-1-US – February rainfall 2024 (0.006 mg/L) ▪ BHMW312 – November (0.007mg/L)
Iron	mg/L	0.05	-	<0.05-7.7	<0.05 - 7.7	178	-	All samples for this analyte were consistent with pre-construction monitoring data, except for the following: ▪ WC BlueWren Ck-DS – June (7.4 mg/L), October (6.8 mg/L) and December (5.1 mg/L)
Lead	mg/L	0.001	0.0056	<0.001-0.014	<0.001 - 0.006	178	1 during rainfall event	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 3-2-DS – November (0.006 mg/L rainfall)
Manganese	mg/L	0.005	2.5	<0.005-5	<0.005 - 1	178	2	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria.

Analyte	Units	LOR	ANZG (2018) criteria	Detected Concentration Range (Groundwater)	Detected Concentration Range (Surface Water)	Total primary samples taken	Number of samples that exceeded ANZG criteria	Exceedances above Pre-construction and ANZG criteria
Mercury	mg/L	0.0001	0.0019	<0.0001	<0.0001	178	0	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria.
Nickel	mg/L	0.001	0.013	<0.001-0.15	<0.001 - 0.025	178	19	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 4-2-DS – January (0.025 mg/L)
Zinc	mg/L	0.005	0.015	<0.005-0.3	<0.005 - 0.24	178	55 (13 during rainfall events)	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 3-2-DS – November (0.11 mg/L rainfall and 0.24 mg/L monthly), ▪ WC 4-2-DS – January (0.079 mg/L), ▪ WC 4-3-US – October (0.016 mg/L) and November (0.016 mg/L monthly and 0.021 mg/L rainfall), ▪ WC 5-1-DS – November (0.039 mg/L monthly)
Field pH	pH units	0.01	6.0-8.0	4.34-7.56	5.20 - 9.91	178	25	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 1-3-DS – November (9.91), December (8.93) and February 2024 (8.94) ▪ WC 3-2-DS – March (5.75), April (5.90), November (5.20 and 5.29)
Total Phosphorus*	mg/L	0.01	0.05	<0.01-3.9	<0.01 - 0.89	178	76	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria.

Analyte	Units	LOR	ANZG (2018) criteria	Detected Concentration Range (Groundwater)	Detected Concentration Range (Surface Water)	Total primary samples taken	Number of samples that exceeded ANZG criteria	Exceedances above Pre-construction and ANZG criteria
Total Nitrogen as N	mg/L	0.2	0.5	<0.2-6.74	<0.2 - 15	178	103 (29 during rainfall event)	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 1-1-US – October monthly event (2.3 mg/L) ▪ WC 1-3-DS – October monthly event (4.8 mg/L) ▪ WC3-2-DS – March (9.3 mg/L), April (2.1 mg/L), November rainfall event (2.7 mg/L) ▪ WC 4-1-US – August (8.9 mg/L), October monthly event (1.8 mg/L) ▪ WC 4-2-DS – August monthly event (5 mg/L) ▪ WC 4-3-US – May (2.3 mg/L), October (4.7 mg/L) ▪ WC BlueWren Ck-DS – August rainfall event (4.7 mg/L), October rainfall event (15 mg/L) ▪ BHMW317 – February (6.74 mg/L), May (2.74 mg/L) ▪ BHMW309 – February rainfall 2024 (2.5 mg/L) ▪ BHMW312 – February rainfall 2024 (2.4 mg/L)
Field Electrical Conductivity	µs/cm	1	2200	82.2 - 13145	133.1 - 52064	178	27 (2 during rainfall event)	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria. Note that during pre-construction WC Ironbark Ck-DS reported EC of 8000 µs/cm, likely denoting the maximum reading possible on the equipment used.

Analyte	Units	LOR	ANZG (2018) criteria	Detected Concentration Range (Groundwater)	Detected Concentration Range (Surface Water)	Total primary samples taken	Number of samples that exceeded ANZG criteria	Exceedances above Pre-construction and ANZG criteria
Total Suspended Solids	mg/L	5	-	<5-2700	<5 - 760	178	-	All samples for this analyte were consistent with pre-construction monitoring data and the ANZG criteria, except for the following: ▪ WC 1-1-US – October (1000 mg/L) ▪ WC 1-3-DS – March (230mg/L), October rainfall event (160mg/L) ▪ WC 3-2-DS – April (143mg/L), October rainfall event (760 mg/L), November (210mg/L) ▪ WC 4-1-US – October rainfall event (340mg/L) ▪ WC 4-2-DS – May (15mg/L), July (25mg/L), August (20mg/L), September (95mg/L), October rainfall event (290mg/L), November rainfall event (19mg/L), January (22mg/L) ▪ WC 4-3-US – July (28mg/L), October rainfall event (220mg/L) ▪ WC BlueWren Ck-DS – June (23mg/L), August rainfall event (17mg/L), October rainfall event (98mg/L), November rainfall event (35mg/L) and February rainfall 2024 (120 mg/L) ▪ WC Ironbark Ck-DS – April (46mg/L), June (36mg/L), September (42mg/L), October rainfall event (230mg/L), November rainfall event (77mg/L), January (40mg/L) and February rainfall 2024 (120 mg/L)

Notes:

- Laboratory Limit of Reporting (LOR), milligram per litre (mg/L), micro-Siemens per centimetre (µS/cm)
- *: Total Phosphate (as P) analysed for water samples in lieu of total Phosphorus. It is noted that these are equivalent, with phosphate typically used on water assessments and phosphorus used on soil assessments.

4.2.4 Upstream versus Downstream Comparison

The monitoring program stipulates that to assist in the meaningful comparison of water quality results a comparison between upstream and downstream locations is conducted. Monitoring data will be assessed, and an investigation triggered if a downstream parameter is reported to exceed the corresponding upstream parameter during a single monitoring event by more than 20%.

For the purposes of comparing surface water qualities upstream of the site versus directly downstream of the site two sets of locations are available; WC 1-1-US and WC 1-3-DS on creek one and WC 4-1-US and WC 4-2-DS on creek four. It is noted that WC-4-1-US has been chosen over WC 4-3-US as the latter is regularly observed to

be dry or not flowing which provides less data for comparative purposes. **Table 4-4** provides a summary of downstream locations where a parameter is reported to exceed the same parameter at its corresponding upstream location, for the 16 monthly and high rainfall (>25mm within 24 hours) surface water monitoring events undertaken during the annual period, excluding the February 2023 pre-construction monitoring event. Creek one recorded 76 instances (29.7%) where the downstream concentration exceeded the upstream counterpart during a monitoring event. Creek 4 reported 80 instances (31.25%) where the downstream concentration exceeded the upstream counterpart during a monitoring event.

Rainfall events reported >20% exceedances of the downstream parameter 38 (29.7%) out of 128 comparisons, whilst monthly events reported 117 (30.4%) out of 384.

Table 4-4: Upstream versus downstream surface water monitoring locations comparison

Parameter	Creek 1, WC 1-1-US vs WC 1-3-DS		Creek 4, WC 4-1-US vs WC 4-2-DS	
	Number of times downstream exceeded upstream by >20% (16 total surface water events)	Months exceeded	Number of times downstream exceeded upstream by >20% (16 total surface water events)	Months exceeded
Turbidity (NTU)	5	March, April, August (rainfall) and December 2023 and January 2024	12	March, April, May, June, July, August (rainfall and monthly), September, November (rainfall and monthly), December 2023 and January, February (monthly) 2024
Electrical Conductivity (µs/cm)	0	None	8	June, July, August (rainfall), September, October (monthly), December 2023 and January, February (monthly) 2024
pH	6	August (monthly), November (monthly), December 2023 and January, February (monthly and rainfall) 2024	0	None
Aluminium (mg/L)	2	February (monthly and Rainfall) 2024	4	March, April, July 2023 and February (monthly) 2024
Arsenic (mg/L)	1	August (rainfall) 2023	0	None
Boron (mg/L)	10	May, June, July, August (monthly and rainfall), October (monthly), November (monthly and rainfall) 2023 and January, February (monthly) 2024	2	December 2023 and February (rainfall) 2024

Parameter	Creek 1, WC 1-1-US vs WC 1-3-DS		Creek 4, WC 4-1-US vs WC 4-2-DS	
	Number of times downstream exceeded upstream by >20% (16 total surface water events)	Months exceeded	Number of times downstream exceeded upstream by >20% (16 total surface water events)	Months exceeded
Cadmium (mg/L)	0	None	0	None
Chromium (mg/L)	0	none	0	none
Copper (mg/L)	9	March, July, August (rainfall and monthly), September December 2023 and January, February (rainfall and monthly) 2024	8	March, May, August (rainfall and monthly), September, October (rainfall), November (rainfall), December 2023
Iron (mg/L)	0	None	3	March, April, August (rainfall) 2023
Lead (mg/L)	0	None	0	None
Manganese (mg/L)	2	March, August 2023	9	March, April, June, August (rainfall), September, October (monthly), November (monthly and rainfall) 2023 and January 2024
Mercury (mg/L)	0	None	0	None
Nickel (mg/L)	12	March, April, May, June, July, August (monthly and rainfall), October (monthly), November (monthly) December 2023 and February (monthly and rainfall) 2024	7	September, October (rainfall), November (monthly), December 2023 and January, February (monthly and rainfall) 2024
Zinc (mg/L)	6	March, May, July, August (rainfall), September 2023 and February (monthly) 2024	6	March, May, November (monthly and rainfall) 2023 and January, February (rainfall) 2024
Total Phosphate (mg/L)	6	June, August (monthly and rainfall), November (monthly and rainfall) 2023 and January 2024	5	March, August (rainfall), September, October (rainfall), November (rainfall) 2023

Parameter	Creek 1, WC 1-1-US vs WC 1-3-DS		Creek 4, WC 4-1-US vs WC 4-2-DS	
	Number of times downstream exceeded upstream by >20% (16 total surface water events)	Months exceeded	Number of times downstream exceeded upstream by >20% (16 total surface water events)	Months exceeded
Total Nitrogen (mg/L)	11	March, April, May, June, July, August (monthly and rainfall), October (monthly), November (monthly and rainfall) 2023 and January 2024	7	April, May, August (rainfall), September, November (monthly and rainfall) 2023 and February (monthly) 2024
Total Suspended Solids (mg/L)	6	March, April, August (monthly and rainfall), September, November (monthly) 2023	9	May, July, August (monthly), September, October (monthly), November (rainfall), December 2023 and January, February (monthly) 2024

5 TRENDS

Field and analytical data trends are summarised in **Appendix C**, with comparison to trigger values**.**

5.1 HYDROCARBONS

Hydrocarbons are analysed when there was either a known hydrocarbon release on-site or if olfactory indicators of contamination are detected during field works (i.e., observed hydrocarbon odours or sheen). There was one detection of suspected hydrocarbon sheen during field works at WC 3-2-DS in May 2023. The analytical results were found to be below the laboratory limit of report (LOR).

5.2 DISSOLVED METALS

5.2.1 Aluminium

Concentrations of aluminium were generally below the laboratory LOR and/or the ANZG (2018) criteria at most locations except for occasional exceedances at select groundwater monitoring locations (BHMW303 – February and May 2023, BHMW309 – February 2023 and BH307 – February 2023), and at all surface water monitoring locations except WC 5-1-DS, including upstream locations.

Surface water results were reported above the pre-construction baseline data in 11 (9.4%) out of 117 samples. This may indicate naturally high concentrations or existing external factors affecting this location during these sampling dates. No groundwater results were reported above the pre-construction monitoring maximum reported.

5.2.2 Arsenic

Reported Arsenic concentrations did not exceed the ANZG criteria. Concentrations remained generally stable at all sampled surface water and groundwater locations, with the exception of BHMW315 which reported results greater than the laboratory LOR during all sampling events. However, results reported at BHMW315 were generally consistent with pre-construction results.

Reported concentrations of Arsenic in surface water samples were marginally elevated compared to the pre-construction results in 37 (31.6%) out of 117 samples at all locations except WC 4-2-DS and WC 5-1-DS, likely attributed to natural background fluctuations or external influences given the urban setting of the site.

5.2.3 Boron

Boron concentrations were generally reported below the laboratory LOR and/or the ANZG (2018) criteria at most sampled groundwater and surface water locations, with the exception of five occurrences of boron concentrations identified at WC Ironbark Ck-DS above the ANZG (2018) criteria, on 30 June, 24 August, 16 November, 25 October and 18 December. Pre-construction phase monitoring did not analyse for Boron at surface water locations, however, baseline data for comparative purposes were drawn from February 2023 monitoring, which occurred prior to construction commencing. Comparison to these results reported a total of 41 (35%) out of 117 exceedances of the February 2023 data. These exceedances were generally minor and may be reflective of longer-term background variability in boron in the wider area.

Ironbark creek is the largest tidal creek draining into the hunter river through floodgates at Sandgate (SGWQCMP). Boron concentrations are known to be naturally occurring within seawater at a range between 0.5 mg/L to 6.0 mg/L and during the four months where an exceedance above the ANZG criteria was reported, the electrical conductivity results indicated that the surface water environment ranged from brackish to seawater. **Figure 5-1** presents a comparison between EC and Boron concentrations at WC Ironbark Ck-DS. Elevated boron concentrations are therefore strongly correlated with brackish to saline water and are not reflective of site conditions.

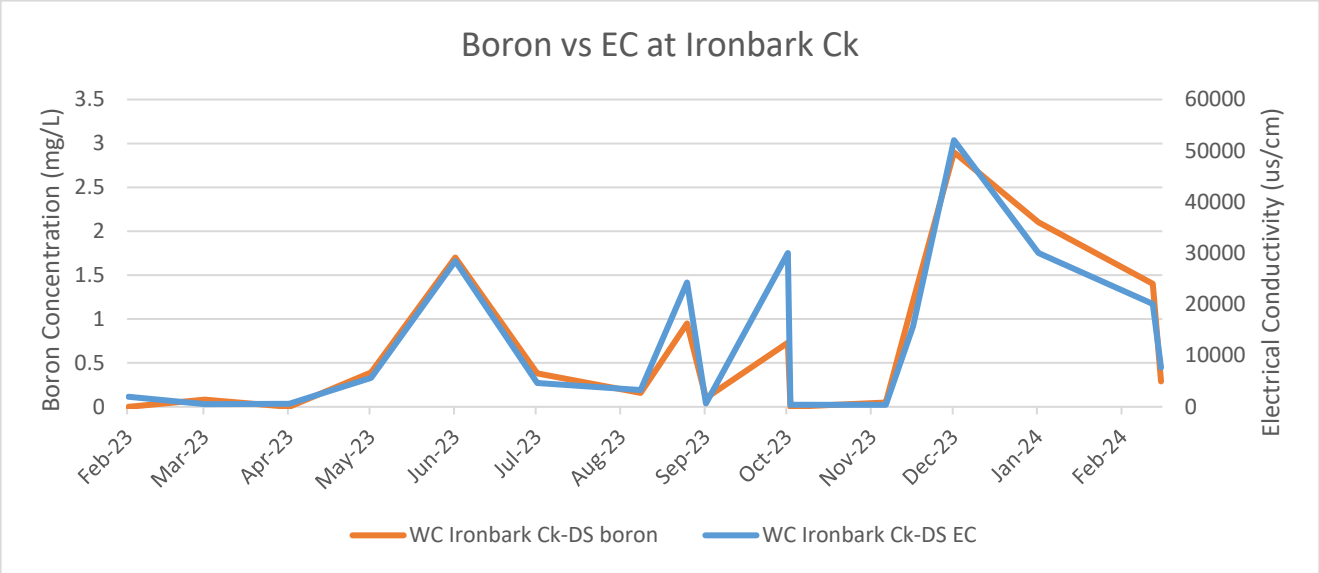


Figure 5-1: Boron and electrical conductivity at WC Ironbark Ck-DS

5.2.4 Cadmium

Cadmium concentrations remained generally below the laboratory LOR and adopted ANZG (2018) criteria at all sampled surface water and groundwater locations, with the exception of one surface water result at WC 3-2-DS in November 2023 exceeding ANZG criteria. A total of 8 (6.8%) out of 117 surface water samples were reported above the adopted pre-construction baseline data.

It is noted that the downstream locations WC Ironbark Ck-DS (0.0003 mg/L) and WC 4-2-DS (0.0002 mg/L) reported a cadmium concentration above laboratory LOR but below the ANZG (2018) criteria during the December 2023 and January 2024 monthly monitoring events respectively. Given the low criteria for cadmium, as well as previously reported detectable concentrations of cadmium at WC 3-2-DS, it is considered likely that elevated cadmium concentrations reported at the site are reflective of natural variability and are not reflective of an increase in cadmium concentrations as a result of site operations.

5.2.5 Chromium

Chromium concentrations remained generally stable and below the adopted ANZG (2018) criteria and the pre-construction monitoring results at all sampled surface water and groundwater locations.

5.2.6 Copper

Concentrations of copper in surface waters were found to be above the adopted ANZG (2018) criteria in all sampled locations in a total of 74 (63.2%) out of 117 samples, which can be attributed to natural background concentrations and the disturbed urban setting of the site. Copper concentrations are potentially loosely affected by rainfall events with higher concentrations reported at a number of locations during higher rainfall months. Concentrations of copper in groundwater were generally found to be stable, with a total of 19 exceedances of the adopted ANZG (2018) criteria.

There were 27 (23%) out of 117 samples reported in exceedance of the pre-construction copper concentrations in surface water during the monitoring period, these are outlined in **Table 4-3**. These exceedances of the pre-construction data are likely attributed to the small data set available (six results per location recorded over a period of four months in autumn and spring of 2020 and a single result from February 2023) for pre-construction monitoring, which is unlikely to fully account for natural background fluctuations and external off-site factors relating to the urban setting of the site.

5.2.7 Iron

Iron concentrations remained generally stable and below the pre-construction monitoring results at all sampled groundwater locations. There is no ANZG (2018) criteria for Iron as such results are compared with pre-construction baseline data.

Iron concentrations reported at surface water locations were variable and reported a total of 80 (68.4%) out of 117 exceedances of adopted pre-construction baseline data. Reported iron concentrations were found to be generally correlated with high rainfall (>25 mm in 24 hour). Decreasing concentrations were noted during high rainfall events and increasing concentrations noted during prolonged dry periods. Iron concentrations may be indicative of the urban setting of the site or leaching of iron from exposed soils.

5.2.8 Lead

Lead concentrations remained generally stable and below the adopted ANZG (2018) criteria and/or the pre-construction monitoring results at all sampled surface water and groundwater locations, with the exception of the following occasions:

- BHMW309, reported above the ANZG (2018) criteria but below the pre-construction baseline data in August 2023.
- WC 3-2-DS, reported above the ANZG (2018) criteria and pre-construction baseline data in November 2023 high rainfall event.
- WC 4-3-US and WC Ironbark Ck-DS, which were both reported above the pre-construction baseline data on one occasion, in November and December 2023 respectively.

Lead concentrations were found to be below the laboratory LOR during the majority of groundwater and surface water sampling events (96.9% of the time for groundwater and 94.9% of the time for surface water). Exceedances of the adopted criteria were minor and are likely attributable to the urban setting of the site.

5.2.9 Manganese

Manganese concentrations remained generally stable and below the adopted ANZG (2018) criteria, with the exception of two exceedances reported at BHMW303, which is located upslope of the site. All surface water results were below the adopted ANZG (2018) criteria, however, a total of 30 (25.6%) out of 117 surface water samples were reported above the pre-construction baseline data. Manganese in surface water was observed to be variable, and similarly to iron, generally decreased in concentration during high rainfall events. Manganese concentrations may be indicative of the urban setting of the site or leaching of manganese from exposed soils.

5.2.10 Mercury

Mercury concentrations remained stable and below the adopted ANZG (2018) criteria and the pre-construction monitoring results at all sampled surface water and groundwater locations. All mercury results obtained for groundwater and surface water were reported below the laboratory LOR.

5.2.11 Nickel

A total of 11 (38%) out of 29 groundwater samples were reported above the adopted ANZG (2018) criteria. No groundwater results were reported above the pre-construction baseline data. One surface water result was reported above the ANZG (2018) criteria at WC 4-2-DS (0.025mg/L). 12 (10.2%) out of 117 surface water samples were reported above the pre-construction baseline data.

Nickel concentrations were generally stable and were below or slightly above the laboratory LOR in all surface water samples. Exceedances of the adopted criteria were minor and are likely attributable to the urban setting of the site.

5.2.12 Zinc

Concentrations of zinc were found to be above the adopted ANZG (2018) criteria in a total of 19 (65.5%) out of 29 groundwater samples (BHMW303, BHMW309, BHMW312, BHMW314, BHMW315, BHMW318, BHMW321, BH307 and BH310), and in 33 (28.2%) out of 117 surface water samples (all locations except WC 4-1-US and WC 1-3-DS), which can be attributed to natural background concentrations and the disturbed urban setting of the site. 13 (11.1%) surface water samples were reported above the pre-construction baseline data. No groundwater results were reported above the pre-construction baseline data.

Results obtained for zinc are likely attributed to the small data set available for pre-construction monitoring, which is unlikely to fully account for natural background fluctuations and external off-site factors relating to the urban setting of the site.

5.3 NUTRIENTS

5.3.1 Total Nitrogen

Total Nitrogen results were found to exceed the adopted ANZG (2018) criteria in 21 (56.8%) groundwater samples and 75 (64.1%) surface water samples. No groundwater samples were reported above the pre-construction baseline data. 14 (12%) surface water samples were reported above the pre-construction baseline data.

5.3.2 Total Phosphorous

Total phosphorous results were found to exceed the adopted ANZG (2018) criteria in 20 (54%) groundwater samples and 43 (36.8%) surface water samples. No groundwater samples were reported above the pre-construction baseline data. Seven (6%) surface water samples were reported above the pre-construction baseline data.

Given the site setting in a heavily disturbed urban environment, nutrient (nitrogen and phosphorous) concentrations would be anticipated to fluctuate significantly with nutrient-laden stormwater runoff from urban environments. It is therefore possible that detected elevated nutrient concentrations are reflective of the wider environment and not of site conditions.

5.4 PHYSICAL AND CHEMICAL STRESSORS

5.4.1 pH

pH was generally found to be stable during the monitoring period. A total of two (5.4%) groundwater results and 18 (15.4%) surface water results were reported outside of the adopted performance criteria range, and a total of 28 (23.9%) surface water results were reported outside of the pre-construction baseline data range.

Results obtained indicate that the pH reported outside of the acceptable criteria range during monitoring events could have been influenced by local conditions within the creek lines and was unlikely to be the result of acidic or alkaline water discharged from the site. As per Section 6.2.3, Management Response, of the SGWQCMP exceedances were immediately reported to Fulton Hogan, who initiated an investigation by Fulton Hogan personnel to determine the significance and possible cause of the exceedance, with results from these triggered investigations provided within the Fulton Hogan annual report.

5.4.2 Turbidity

Turbidity readings have generally remained stable and below the criteria and historic pre-construction results at most locations during this year. However, during specific monitoring events, particularly following high rainfall in March, October and November 2023, turbidity increased at WC 1-3-DS, WC 3-2-DS and WC 4-1-US.

It is noted that during the only two events where WC 2-2-DS was sampled due to available flowing water, turbidity results exceeded ANZG criteria. This is likely due to the ephemeral nature of the creek lines in this location. There is approximately 400 metres of ephemeral creek line between the sediment basins 9680E and 9560E to the sampling location WC-2-2-DS. The area is generally dry bushland and dry creek lines between the sediment basins and the monitoring location WC-2-2-DS. Water does not generally flow at WC-2-2-DS however following the high rainfall event on 5 November 2023, when 99mm of rain was reported to have fell, water was observed to be flowing through this location during the 6 and 16 November 2023 monitoring events.

Turbidity concentrations reported during the study were highly variable and were likely influenced by conditions within creek lines. Creek lines in the study area were ephemeral or low flowing, which contributed to the build-up of debris and sediments within the creek lines, increasing the turbidity levels during rainfall events, likely impacting on the reported results. This is evidenced by the increase in turbidity following rainfall, with settled debris likely flushed out of the creek lines during rainfall.

5.4.3 Electrical Conductivity (EC)

Electrical conductivity in surface water was reported below the adopted performance criteria at all locations, with the exception of Ironbark Ck-DS, which reported 11 exceedances of the adopted performance criteria. These exceedances were determined to be due to brackish or saline water present at the sampling location associated

with tidal influences within the nearby Hunter River. A total of 24 (20.5%) surface water results were reported outside of the pre-construction baseline data range, however, these exceedances were generally minor.

Electrical conductivity in groundwater was generally consistent with pre-construction baseline data. A total of three groundwater results were reported below the pre-construction baseline data. 10 (27%) groundwater results were reported above the adopted performance criteria. Variations in observed electrical conductivity were likely due to natural variability within sampling locations and were unlikely to be reflective of site operations.

5.4.4 Total Suspended Solids (TSS)

TSS results were reported above the pre-construction baseline data in two groundwater samples, and 41 (35%) surface water samples. TSS concentrations reported during the monitoring period were highly variable and were likely influenced by conditions within creek lines. Creek lines in the study are ephemeral or low flowing, which contributed to the build-up of debris within the creek lines, increasing the natural TSS levels of the creek lines and likely impacting on the reported results. This is evidenced by the increase in TSS following high rainfall events, with settled debris likely flushed out of the creek lines during rainfall.

5.4.5 Dissolved Oxygen (DO)

Dissolved oxygen results were consistently reported below the adopted performance criteria. It is noted, however, that performance criteria require reporting of dissolved oxygen as a percentage, whereas the provided performance criteria and obtained results were reported as milligrams per litre. Exceedances of the provided DO criteria are therefore not reflective of conditions within creek lines at the site and should be reported as DO (%) in future monitoring events.

5.5 RAINFALL

Table 5-1 presents the rainfall data from Newcastle Nobbys Signal Station (Station Number: 061055, Latitude – 32.92 °S, Longitude – 151.80 °E, Elevation – 33 m) and RP2J – Jesmond (in Blue) for the period 2023/24. The project's weather station was installed in March 2023 and was used to record rainfall data once installed. Rainfall totals have fallen below the monthly average for ten out of the past 12 months after a period of above average rainfall experienced through 2022. Rainfall averages fell slightly below monthly means for the first four months of monitoring before a drier period through June, July, September, and early October. Slightly above average rainfall was recorded in August between these drier months. High rainfall was then observed in late October and early November and coincides with increases of many analytes and parameter exceedances. Surface water levels were noted as remaining stable or elevated up until December and January when they began to decrease due to the lower-than-expected rainfalls occurring through the remainder of summer.

Table 5-1: 2023-2024 Rainfall data

Date	Feb (2023)	Mar (2023)	Apr (2023)	May (2023)	Jun (2023)	Jul (2023)	Aug (2023)	Sep (2023)	Oct (2023)	Nov (2023)	Dec (2023)	Jan (2024)
1st	-	0	16.4	0	0	0	0	1.2	0	0.2	0.2	0
2nd	-	0	0.2	0	0	0	0.4	0	0	0	4.4	0
3rd	0	0	0	0	0.2	0	0.2	0	0	0	0.2	0
4th	0	0.4	4.6	0	0	7.2	0.2	6.2	8.4	0	0	1.6
5th	0	0	10	0	0	0.2	0	0.2	0	99.0	0	3.2
6th	0	0	0.2	0	0	0	37	0	6	0	0	0
7th	0	0	4.4	3.0	0.2	0	0.4	0	1.6	0	0	0
8th	0	0	0	4.0	0.4	0	1.2	9.4	0	0	0	1.2
9th	0	0	0	0	0.4	0	0.2	0	0	9	0	0

Date	Feb (2023)	Mar (2023)	Apr (2023)	May (2023)	Jun (2023)	Jul (2023)	Aug (2023)	Sep (2023)	Oct (2023)	Nov (2023)	Dec (2023)	Jan (2024)
10th	0	0	0	0	0	0	0.2	0	0	0	0	0
11th	0	0	0	0	0.2	0	0	0	0	0	0	0
12th	0	0	3.6	0	0.4	0.2	0.2	0.2	0	0	0	0
13th	0	1	9.6	4.2	0.6	0.2	1.4	0.2	0.4	0.2	0	0
14th	7.2	5.6	15	0.2	0.2	0.2	11.8	0.2	0	0	0	4.4
15th	2.6	7.8	0	12.8	0	0	5.6	0.2	0	0	0	0.8
16th	0	0	0	0.2	0	0.4	0.4	0	0	0.2	0	0
17th	0	0	0	27.8	0.2	1.8	6	0	1.2	19.4	0	12
18th	0	0	0	1.4	0.2	1.8	3	0	0.2	0	0	0.2
19th	3	0	0	0	0	0.2	0	0	0	0	0	0
20th	0	0	22	0	0	0	0	0	0	0	17.2	0
21st	0	0.2	0.2	0	0	2.6	0.2	0.2	0	0.2	2.4	0
22nd	15.4	0	1.2	0	0.2	0	0.2	0.4	0	0	0	0
23rd	40.4	0	0	0	2	14.2	3	0.2	0	1	0	0.6
24th	1.4	41.4	1.0	0	0	2.4	0	0	0	2.2	3.6	0
25th	0	8	0	0	0	0.2	0.2	0	0.4	1.4	16.6	0
26th	0	0.2	0	29.2	0	0.4	0.2	0	27.6	1.6	0	0
27th	0	0	0	0	0	0.2	0.2	0	15.4	2	0.2	0
28th	0	26.2	0	0	1.2	0.2	0.2	22.6	4.2	0.2	0	0
29th	-	9.4	20.6	0	0.2	0	0.2	0.2	0	1.2	14.4	0
30th	-	0.2	0.2	0	0	0	6.2	0.2	0	0.2	0	0
31st	-	0	-	0	-	0	0.8	-	0	-	0.8	3.2
Total	70	100.4	109.2	112	6.6	32.6	80.4	41.6	65.4	138	60	27.2
Historical Mean (Station 061055)	79.1	119.7	115.6	114.5	117.1	92.6	72.0	71.3	73.2	71.3	79.1	88.1

5.6 GROUNDWATER ELEVATION

As discussed in **Section 2.4** onsite groundwater monitoring wells are generally either relating to a perched aquifer low yield aquifer located in the higher topography areas which is not interconnected, or the regional aquifer in lower topography areas. Data loggers are deployed within 10 of the 12 wells and have been utilised to understand changes in groundwater elevations over time of construction and during pre-construction monitoring. An error

occurred with all loggers during this monitoring period, with all loggers stopping recording data around the 9th of November 2023. This is likely due to the loggers exceeding memory capacity. Data from these loggers have been downloaded, compensated, and included in **Appendix D**. During the monitoring period a minor reduction in groundwater elevations is apparent, likely due to the generally below average rainfall that was experienced on-site during much of the monitoring period. **Table 5-2** presents the minimum, maximum and average readings from each monitoring well during this annual monitoring period.

Table 5-2: Data Logger Groundwater Elevation Data (mAHD)

Monitoring Location	Feb (2023)			Mar (2023)			Apr (2023)			May (2023)			Jun (2023)			Jul (2023)			Aug (2023)			Sep (2023)			Oct (2023)			Nov (2023)		
	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
BHMW304	70.75	70.84	70.77	70.75	70.81	70.77	70.63	70.81	70.72	70.68	70.73	70.69	70.63	70.71	70.69	70.68	70.7	70.69	70.68	70.74	70.69	70.6	70.71	70.69	70.71	70.68	70.69	70.69	70.73	70.7
BHMW308	48.95	50.11	49.91	48.93	50.06	49.48	48.99	49.7	49.21	48.86	49.66	49.51	49.3	49.52	49.4	48.92	49.31	49.1	48.88	49.04	48.93	48.88	48.98	48.91	48.88	48.9	48.89	48.88	49.19	48.95
BHMW309	25.18	28.63	25.5	24.71	26.21	25.72	25.17	25.66	25.39	24.64	25.39	25.01	24.65	24.67	24.66	24.65	24.67	24.66	24.65	25.34	24.99	24.65	25.89	24.76	25.17	25.76	25.42	25.11	26.49	25.67
BHMW310	18.35	18.38	18.36	18.35	18.38	18.36	18.24	18.4	18.32	18.29	18.32	18.30	18.3	18.32	18.31	18.3	18.32	18.31	18.3	18.32	18.31	18.30	18.32	18.31	18.32	18.32	18.31	18.31	18.33	18.32
BHMW312	7.44	7.79	7.59	7.49	7.66	7.58	7.39	7.66	7.49	6.51	7.44	7.13	6.42	6.66	6.55	6.27	6.68	6.41	6.20	6.47	6.33	6.17	6.34	6.26	6.05	6.27	6.17	6.07	6.26	6.14
BHMW314	-0.43	3.19	3.06	3.03	3.21	3.14	2.96	3.16	3.06	2.79	3.11	2.95	2.70	2.93	2.80	1.85	2.90	2.62	-0.53	3.25	3.11	2.95	3.1	3.02	2.86	3.08	2.96	2.88	3.14	2.98
BHMW315	18.08	21.78	18.33	15.03	18.52	18.52	18.1	18.42	18.26	18.02	18.57	18.31	18.16	18.6	18.42	18.55	18.76	18.67	18.47	18.82	18.63	18.60	18.80	18.72	18.64	18.84	18.74	18.31	18.77	18.62
BHMW316	18.82	19.62	19.49	11.91	19.23	15.11	11.58	18.77	17.63	18.29	19.36	19.2	19.16	19.26	19.2	19.1	19.22	19.16	11.11	18.73	25.88	18.62	18.74	18.67	18.57	18.69	18.63	18.58	18.64	18.61
BHMW317	21.02	21.36	21.15	16.42	21.46	20.56	16.56	21.77	17.49	14.88	21.79	21.41	14.88	21.79	21.41	20.82	20.9	20.86	18.76	21.06	20.46	18.63	18.85	18.72	18.46	18.66	18.56	18.6	19.1	18.78
BHMW318	59.82	60.02	59.91	54.79	60.1	59.86	54.81	60.1	59.21	54.73	55.18	54.92	54.76	55.15	54.95	54.72	54.78	54.74	54.72	55.7	54.93	55.42	55.68	55.56	55.32	55.52	55.41	55.47	55.79	55.68

Notes:

- Australian Height Datum (AHD)

6 QA / QC

6.1 Data Quality Indicators

Data Quality Indicators (DQIs) provide the metrics that the investigation performance is assessed against. **Table 6-1** presents the assessment of performance against these metrics.

Acceptable limits on decision errors, and the manner of addressing possible decision errors, have been developed based on the DQIs of sensitivity, precision, accuracy, representativeness, comparability, and completeness (SPARCC). These are summarised as follows:

- The tolerable limits on decision errors for data that Kleinfelder considers acceptable include:
  - Probability that 95% of data satisfied the DQIs, therefore the limit on the decision error was 5% that a conclusive statement may be incorrect.
- A robust QA/QC program will be implemented to ensure an appropriate sampling and analytical density is adopted and representative sampling undertaken.
- The possible outcomes on making an error in the decision are:
  - Basing decisions on unreliable data and consequently making incorrect decisions regarding the acceptability of current site conditions; and
  - Basing decisions on unreliable data and inappropriately recommending the need for further investigation, action and/or management.
- The DQI's are described below, as presented in **Table 6-1**.

Table 6-1: QA/QC data quality indicators

QA/QC objective	Data quality indicator (DQI)
Suitable environmental consultant	The environmental consultant will maintain QA Systems certified to AS/NZS ISO 9001:2015.
Suitable field personnel	All Kleinfelder field personnel conducting sampling will be trained in the requirements detailed in the SAQP. All Kleinfelder field personnel will have relevant tertiary qualifications and will be required to demonstrate competence in Kleinfelder procedures for sampling (consistent with NEPM2013 and AS4482.1 – 1999).
Adequate sample collection density	The sampling strategy has been developed based on EPL requirements and the SGQCMP (including document revisions). The sampling frequency was undertaken monthly with additional groundwater locations included each quarter. Gauging of groundwater across the site was undertaken quarterly throughout the monitoring period to assess groundwater elevations.
Standardised sample nomenclature	All samples will be labelled with a unique identifier that can be related to surveyed sample location and depth. The following naming convention has been continued from the previous investigation to maintain consistency: • Existing Monitoring well location (i.e. BHMW3), location number (01, 02), E.g. BHMW301, • Other existing well location (i.e. BH), Location number (01, 02), E.g. BH307, • Surface water location (i.e. WC), Creek number/name (1-4, BlueWren Ck, Ironbark Ck), location up or down stream (US, DS) E.g. WC 1-1-US
Decontamination of field equipment	When sampling equipment is used, nitrile gloves will be worn and changed between samples. Equipment will also be decontaminated between sample locations using an appropriate low phosphate surface-active cleaning agent (e.g. Liquinox) as consistent with HEPA and NEPM and rinsed with de-ionised water.
Calibration of field instruments	All field instruments will be calibrated prior to use, and the calibration will be documented in each monthly report.

QA/QC objective	Data quality indicator (DQI)
Transportation	A COC document will be used to ensure the integrity of the samples from collection to receipt by the analytical laboratory within appropriate holding times.
National Association of Testing Authorities (NATA) accredited laboratory analysis	All samples will be forwarded to a laboratory holding NATA accreditation for the required analyses. The following Laboratories will be utilised: • Eurofins – Primary Laboratory for chemical analysis; and • ALS – Secondary Laboratory for chemical analysis.
Field QA/QC	Duplicate samples (intra-laboratory) will be collected at a rate of one in every twenty (1:20) primary samples and submitted to the primary laboratory for analysis. Triplicate samples (inter-laboratory) will be collected at a rate of one in every twenty (1:20) primary soil samples and submitted to the secondary laboratory for analysis. Field duplicate and triplicate samples are used to assess field and analytical precision and the precision measurement is determined using the relative percent difference (RPD) between the primary sample (X1) and duplicate sample (X2) results, as shown in the following equation: Relative percent difference (RPD) = $\frac{(X1 - X2)}{(X1 + X2)/2} \times 100$ Generally, it is recommended that RPD is not >50%. Default RPD levels in the field may be non-compliant for the following reasons: • Although all due care and attention will be taken to obtain samples containing the same material, when collecting duplicate samples the low flow micropurge pump retrieves a consistent flow of materials that may not be consistent based on the volume of material available and the groundwater flow within the monitoring location. • The differing laboratory equipment, procedures and limits of reporting (between the primary and secondary laboratories); • Due to sample matrix interference; and • Due to the reported concentrations being close to the limit of reporting where laboratory precision and accuracy are inherently low. A rinsate blank sample will be collected for each piece of non-dedicated sampling equipment per day onsite and submitted to the primary laboratory for analysis; and A transport blank sample will be collected for each batch of samples sent to the laboratory (~one per day in the field) and submitted to the primary laboratory for analysis for each day samples are taken. Should rinsate and transport blank analysis identify concentrations above the Laboratory LOR, this will indicate the potential for cross contamination and further discussions will be required to determine the integrity/validity of the data. QA/QC non-compliance will be documented and discussed in the annual report. Should exceedances be identified (i.e. duplicates and triplicates be above the RPD or rinsate blanks or transport blanks be above the laboratory LOR then consideration will be given to the sample(s) being re-analysed or the higher concentration being conservatively adopted.
Laboratory Quality Control – Duplicates, spikes, blanks and surrogates – Acceptable Limits	Laboratory QA/QC acceptance limits are as follows: • Surrogates: 70% to 130% recovery, • Matrix Spikes: 70% to 130% recovery for organics or 80% to 120% recovery for inorganics, • Control Samples: 70% to 130% recovery for soil or 80% to 120% recovery for waters, • Duplicate Samples: <4 Practical Quantitation Limits (PQL) - +/- 2PQL, 4-10PQL – 0.-25 or 50%RPD, >10PQL – 0-10 or 30%RPD; and • Method Blanks: zero to <PQL.

In order to ensure appropriate analytical concentrations are obtained, **Table 4-3** provides the laboratories LOR adjacent to the adopted trigger value.

6.2 Field Method Validation

To ensure the completeness, comparability, representativeness, precision and accuracy of QA/QC items, **Table 6-2** details how the DQI's have been met.

Table 6-2: QA/QC objectives and DQIs

QA/QC objective	Data quality indicator (DQI)
Suitable field personnel	The site work was undertaken and supervised by Aaron King and Tom Jeffery under the direction of Dan Kousbroek. All staff are suitably experienced in compliance monitoring programs. Aaron and Tom were informed of the requirements of the agreed scope of works. Dan, Aaron and Tom have relevant tertiary qualifications and have demonstrated competence with Kleinfelder's sampling procedures (consistent with NEPM 2013 requirements and AS4482.1 2005).
Adequate sample collection density	Samples were collected monthly at approximately the same time of the month.
Field equipment	A YSI Pro DSS Water Quality Meter was used during field works. Where a YSI Pro DSS water Quality Meter was unable to be used to report pH, samples were collected for laboratory pH analysis.
Calibration of field instruments	The calibration certificate has been provided in each of the monthly reports.
Sample preservation	Samples were collected in laboratory supplied containers and immediately stored in an insulated esky chilled with ice.
Sample handling	At the end of the sampling event, samples were taken to the Eurofins laboratory in Mayfield. Eurofins then transferred them to their relevant analytical facility and forwarded relevant samples to ALS for QC analysis. Chains of custody are included in each of the monthly reports.

6.3 Field and Laboratory QA / QC

The results for internal laboratory QA/QC procedures are provided within the laboratory analysis reports, included in each monthly report. **Table 6-3** summarise conformance to specific QA/QC procedures.

Table 6-3: QA/QC

Quality assurance	Conformed	Comment
Collection of rinsate water from decontaminated field equipment	Yes	A rinsate sample was taken from the sampling equipment (interface probe and water quality meter) during each sampling event. Over the 12-month period, most samples were reported below the laboratory LOR, except on one occasion: • 19 May 2023: Chromium (0.001 mg/L) Based on the chromium results obtained during the investigation, which were always below the laboratory LOR and/or below the adopted criteria, this result was unlikely to have adversely impacted the results obtained.
Holding times met	Yes	Samples were taken directly to the laboratory following sampling on the same day. Holding times were generally met for all analytes and samples, with the exception of: March 2023 ALS report: TSS for QC01A and QC02A (4 days overdue)

Quality assurance	Conformed	Comment
LOR less than assessment criteria	Yes	ANZG (2018) criteria utilised for this program are incorporated into the SGWQCMP and took into consideration laboratory LORs and appropriate criteria generated.
All analyses by National Association of Testing Authorities (NATA) accredited	Yes	All samples were delivered to a NATA accredited laboratory for the required analysis, within specified holding times. The primary laboratory used was Eurofins. Samples were delivered to their Newcastle Lab and then distributed as required to the appropriate Eurofins analytical centre. Triplicate samples were forwarded by Eurofins to the secondary laboratory, ALS (Sydney).
Field intra-laboratory duplicate samples collected and analysed to represent 5% (or 10% for PFAS) of the sample population	Yes	Intra-laboratory duplicate samples and Inter-laboratory triplicate samples were collected throughout the 12-month period at the correct rate (1:). **Table 6-4** provides a summary of QC program.
Did duplicate sample meet RPD requirements	Majority	The majority of samples met the RPD requirements of being within 50%. Samples that did not meet the RPD requirements are highlighted within the results tables (**Appendix B, Tables QC1, QC2 and QC3**). As discussed in **Table 6-1** that although all due care and attention was taken to obtain samples containing the same material, it may have been feasible that sample interference occurred especially if there is a large amount of turbidity present. A number of the reported concentrations were close to the limit of reporting where laboratory precision and accuracy are inherently biased low. Over the 12-month period there were ten dissolved metals RPD value exceedances and 26 inorganics/nutrients RPD exceedances reported. In general, for the majority of the exceedances at least one sample was found to be below the Laboratory LOR, which leads to exaggerated RPD calculations. In order to take a conservative approach, the highest recorded concentration was selected for results comparison to trigger values. These RPD exceedances are therefore not considered to have an impact on the outcome of the assessment.
Did triplicate sample meet RPD requirements	Majority	The majority of samples met the RPD requirements of being within 50%. Samples that did not meet the RPD requirements are highlighted within the results tables (**Appendix B, Tables QC1, QC2 and QC3**). As discussed in **Table 6-1** that although all due care and attention was taken to obtain samples containing the same material, it may have been feasible that sample interference occurred especially if there is a large amount of turbidity present. A number of the reported concentrations were close to the limit of reporting where laboratory precision and accuracy are inherently biased low. In general, for the majority of the exceedances at least one sample was found to be below the Laboratory LOR, which leads to exaggerated RPD calculations. In order to take a conservative approach, the highest recorded concentration was selected for results comparison to trigger values. These RPD exceedances are therefore not considered to have an impact on the outcome of the assessment.
Internal laboratory procedures	Majority.	Holding time breaches are discussed above. Internal laboratory QC procedures were generally met, the details of exceedances are provided below:

Quality assurance	Conformed	Comment
		Quality Control sample outliers: • February Eurofins – Lead and Zinc RPD values exceedance, passed internal Laboratory standards • March ALS – Nitrite + Nitrate, background levels equal to or more than four times greater than the spike level. • April ALS – Total Phosphate, background levels equal to or more than four times greater than the spike level. • July ALS – Manganese, background levels equal to or more than four times greater than the spike level. Mercury, recovery less than lower data quality objective. • August Eurofins – Nickel RPD value exceedance, passed internal laboratory standards. • October 25 Eurofins – Arsenic RPD value exceedance, passed internal laboratory standards. • October 27 Eurofins – Zinc RPD value exceedance, passed internal laboratory standards, Total Phosphate sample matrix interference. • November ALS – Total Kjeldahl Nitrogen (TKN), background levels equal to or more than four times greater than the spike level. • December ALS – Manganese, Nitrite + Nitrate and TKN, background levels equal to or more than four times greater than the spike level.

Quality control samples submitted for laboratory analysis as part of the monitoring program are summarised in **Table 6-4.**

Table 6-4: Summary of groundwater QC program

Analysis	Primary Surface Water	Primary Groundwater	Total Primaries	Intra-lab (Duplicate)	Inter-lab (Triplicate)	Rinsate Blank	Totals
TRH/BTEXN Silica Gel Clean-up	1	0	1	0	0	0	1
TSS	120	37	157	9	9	0	175
12 Dissolved Metals – Al, As, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Zn	120	37	157	9	9	12	188
Nutrients: total Nitrogen (TN) Total Phosphorous (TP)	120	37	157	9	9	0	175

6.4 QUALITY STATEMENT

Field sampling procedures generally conformed to Kleinfelder's QA/QC protocols to prevent cross contamination, preserve sample integrity and allow for collection of a suitable data set from which to make technically sound and justifiable decisions with data of satisfactory useability.

Duplicate and triplicate field sample RPD exceedances generally reported that one of the samples relating to the RPD exceedance was found to be below or at the Laboratory LOR, which leads to exaggerated RPD calculations. RPDs above the adopted acceptable limit were observed in a number of inter and intra-laboratory metals samples ranging from to 50 – 186%. The cause of these elevated results is considered to be potential sediment interference within the samples, which may have caused an erroneous result during analysis. As all other

corresponding RPDs were within the acceptable limits and subsequent monitoring has returned consistent results, it is considered that the result for these samples are an anomaly in the data.

As outlined in **Table 6-3** one rinsate exceedance was detected this year for Chromium in May 2023, this result is considered unlikely to have a negative impact upon the results as all primary samples analysed for chromium for May 2023 reported results below the LOR.

A four-day holding time breach occurred for TSS for the quality control sampled delivered to the secondary laboratory for analysis. This analyte has a seven-day holding time, and the results of this sample provided one RPD exceedance marginally outside of Kleinfelder's 50% limit, which has been adopted as a more conservative value.

Nine QC laboratory reports stated matrix spike and/ or laboratory duplicate outliers for organic and dissolved metal analytes. These outliers are internal laboratory procedure outside of Kleinfelder's control. Laboratory spike and duplicate outliers are generally attributed to sample matrix interference. Kleinfelder QA/QC duplicate samples were also collected and provide a separate similar measure of the laboratory result reliability.

Based on a review of the results for the Kleinfelder and laboratory QA/QC program adopted, the overall data quality is considered to be suitably reliable and representative of ground and surface water conditions at the site). Copies of the final NATA endorsed laboratory reports, including internal QA/QC results and chain-of-custody documentation for the primary and secondary laboratories are attached as part of the monthly reports included in **Appendix D.**

6.5 EQUIPMENT CALIBRATION

All equipment used was supplied calibrated with appropriate calibration certificates which are provided as par of the monthly reports (**Appendix D**. Kleinfelder undertook pre-mobilisation checks of equipment (including calibration as required). Prior to commencing field operations, the following equipment and calibration checks were conducted:

- **Water Quality Meter** – The water quality meter came calibrated from the supplier with calibrations undertaken monthly before works commenced.

7 CONCLUSIONS

The sampling and analysis program was successfully completed to meet the requirements of the EPL and SGWQCMP. Analysis of the first year of sampling results have found the following:

- Based on a review of the results for the Kleinfelder and laboratory QA/QC program adopted, the overall data quality is considered to be suitably reliable and representative of groundwater and surface water conditions at the site.
- Following rainfall events, particularly during October and November, numerous analyte and parameter exceedances including Cadmium, Lead, Aluminium, Zinc, turbidity and pH were reported greater than the laboratory LOR and/or the adopted criteria. This is likely reflective of runoff from the surrounding urban environment, as well as a flush-out of settled debris and sediment build-up along creek lines.
- Overall, the majority of analytes were reported below the adopted ANZG (2018) criteria and pre-construction baseline data during the majority of sampling events. Several exceedances were reported during the monitoring period; however, these exceedances are potentially attributable to the urban setting of the site (including stormwater runoff from surrounding residential and commercial premises and roadways), natural seasonal fluctuation of background concentrations of contaminants, and the build-up of debris and sediments within creek lines during dry periods (which is flushed into creek lines in stormwater during rainfall events). None of the exceedances identified were able to be directly or definitively attributed to site operations.
- Furthermore, site operational controls (including (but not limited to) sediment control, waste management, and water management) were undertaken by Fulton Hogan during the monitoring period. These management controls were compliant with the sites' regulatory responsibilities (including the NSW EPA Environment Protection License (EPL) and SGWQCMP), reducing the likelihood of offsite impacts as a result of site operations.
- Kleinfelder has not determined the need for additional management responses at this time. Kleinfelder recommends clarification regarding dissolved metals performance criteria (with exception to Arsenic) which are listed as total metals in the SGWQCMP.

Overall, the water quality results are relatively consistent with the summary provided in the SGWQCMP for the baseline data. Results obtained above the adopted performance criteria were primarily attributable to natural seasonal fluctuations or background concentrations for the urban setting of the site. It is unlikely that site operations have exclusively contributed to exceedances identified in this report and exceedances are likely attributable to natural seasonal fluctuations within the study area or background concentrations for the urban setting of the site.

8 REFERENCES

Advances in Technologies for Boron Removal from Water: A Comprehensive Review (19 September 2022), Xiaowei Liu, Congjin Xu, Peng Chen, Kexin Li, Qikun Zhou, Miaomaio Ye, Liang Zhang, and Ye Lu. Advances in Technologies for Boron Removal from Water: A Comprehensive Review - PMC (nih.gov)

ANZECC/ARMCANZ 2000. Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available: www.waterquality.gov.au/anz-guidelinesANZG 2018

GHD 2016. Newcastle Inner City Bypass – Rankin Park to Jesmond Environmental Impact Statement. Available:

https://roadswaterways.transport.nsw.gov.au/projects/01documents/newcastle-inner-city-bypass/rankinpark-to-jesmond/nicb-eis-environmental-impact-statement-2019-16.pdf

GHD 2018. Newcastle Inner City Bypass – Rankin Park to Jesmond Submissions and Preferred Infrastructure Report. Available: https://roadswaterways.transport.nsw.gov.au/projects/01documents/newcastle-inner-city-bypass/rankinpark-to-jesmond/nicb-submissions-and-preferred-infrastructure-report.pdf

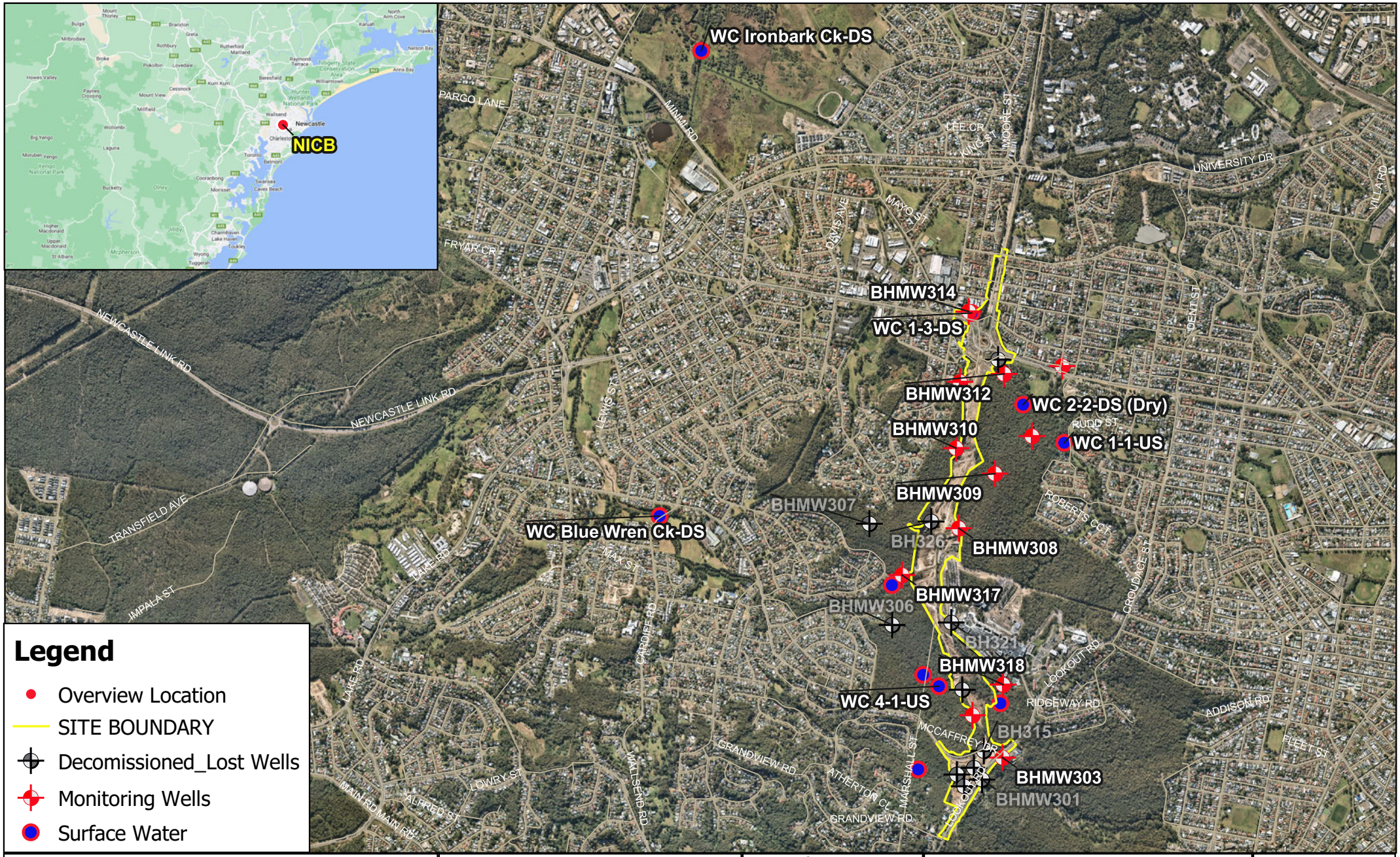
Newcastle Inner City Bypass – Rankin Park to Jesmond Surface water Quality Construction Monitoring Programs, June 2022

Newcastle City Council 2004. Newcastle Stormwater Management Plan (accessed February 2023). Available at: Microsoft Word - Part C_FINAL_June05.doc (nsw.gov.au)

9 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data known to date. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided. The science of climate change and translating climate risks into design criteria are new and evolving practices, involving many uncertainties. The projections made in this report only reflect the professional judgment of the Project Team applying a standard of care consistent with the level of care and skill of other professionals undertaking similar work in the same locality under similar conditions at the date the services are provided. For these reasons, the recommendations, predictions, and projections made within this report provide guidelines based on the knowledge available to Kleinfelder as of the date provided based on Kleinfelder's review of the resources [identified below]. Any predictions or projections made in this report are not guaranteed predictions or projections of future events. Kleinfelder recommends that the results of these evaluations be updated over time as science, data, and modelling techniques advance. Unless so engaged, Kleinfelder disclaims any undertaking to update these predictions in the future. Any reliance upon maps or data presented herein used to make decisions or conclusions is at the sole discretion and risk of the user. This information is provided with the understanding that the data is not guaranteed to be accurate, correct, or complete and assumes no responsibility for errors or omissions. This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report. The work performed was based on project information provided by Client. If Client does not retain Kleinfelder to review any plans and specifications, including any revisions or modifications to the plans and specifications, Kleinfelder assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from Kleinfelder's engineer that such changes do not affect our recommendations. Failure to do so will vitiate Kleinfelder's recommendations. In addition to the above, the footer of letters and letter reports must indicate the Kleinfelder copyright, and the bottom front page of a bound report must contain the following:

APPENDIX A FIGURES



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Project Reference:

Date Drawn: 2023-07-26

Drawn by: D. Kousbroek

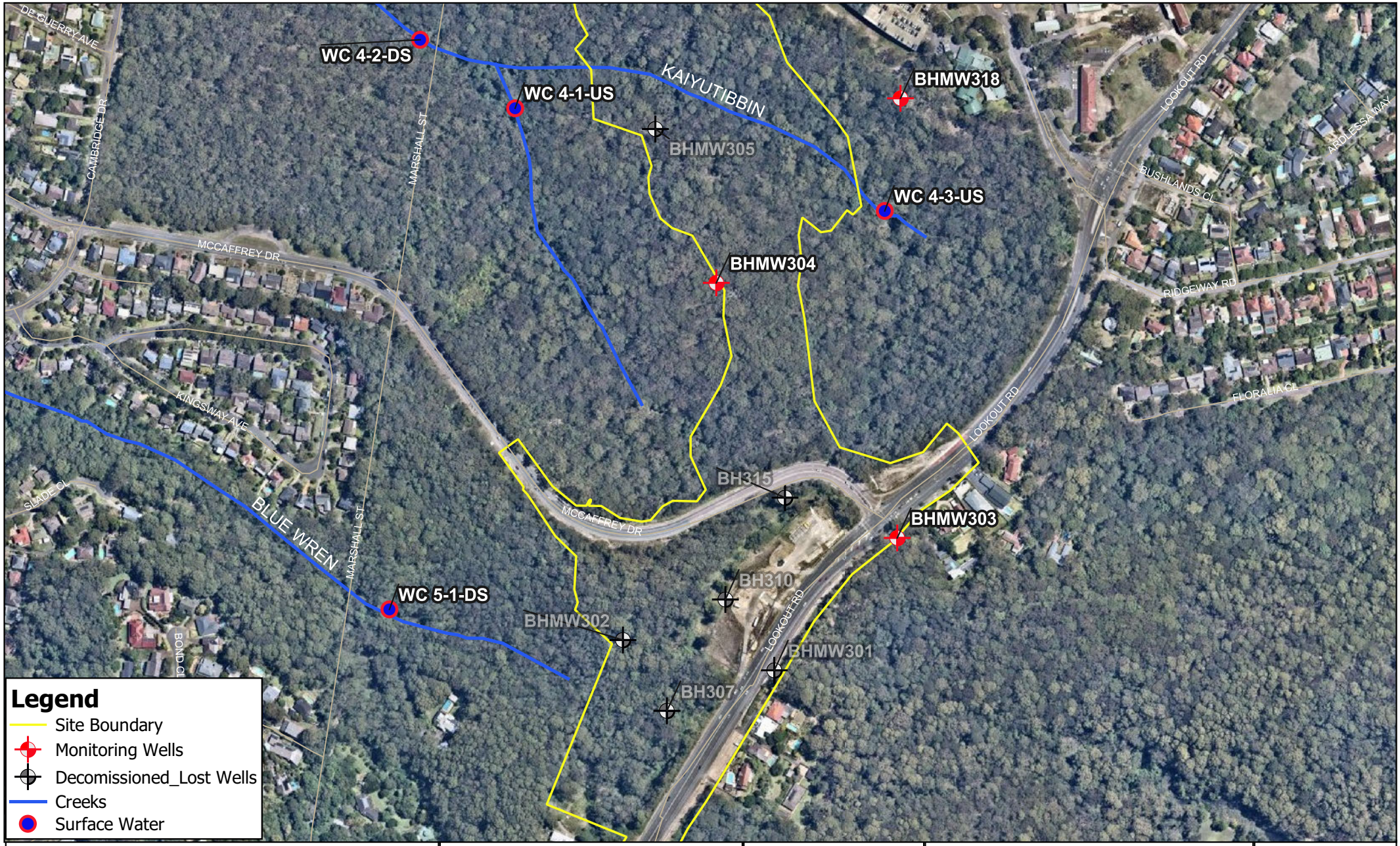
Data Source: Nearmap

NICB - Site Overview

Newcastle Inner City Bypass (NICB) - Surface Water and Groundwater Monitoring Program

Figure: **1**

C:\Users\DKousbroek\OneDrive - Kleinfelder\Documents\GIS\Hutton Hogan NICB



0 100 200 m

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Project Reference: 20234948	**NICB -Southern Water Monitoring Locations**
Date Drawn: 2023-07-26	
Drawn by: D. Kousbroek	
Data Source:Nearmap	NICB - Water Monitoring Program

Figure: **2**

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0 100 200 m

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Project Reference: 20234948	**NICB -Central Water Monitoring Locations**
Date Drawn: 2023-07-26	
Drawn by: D. Kousbroek	
Data Source:Nearmap	NICB - Water Monitoring Program

Figure: **3**

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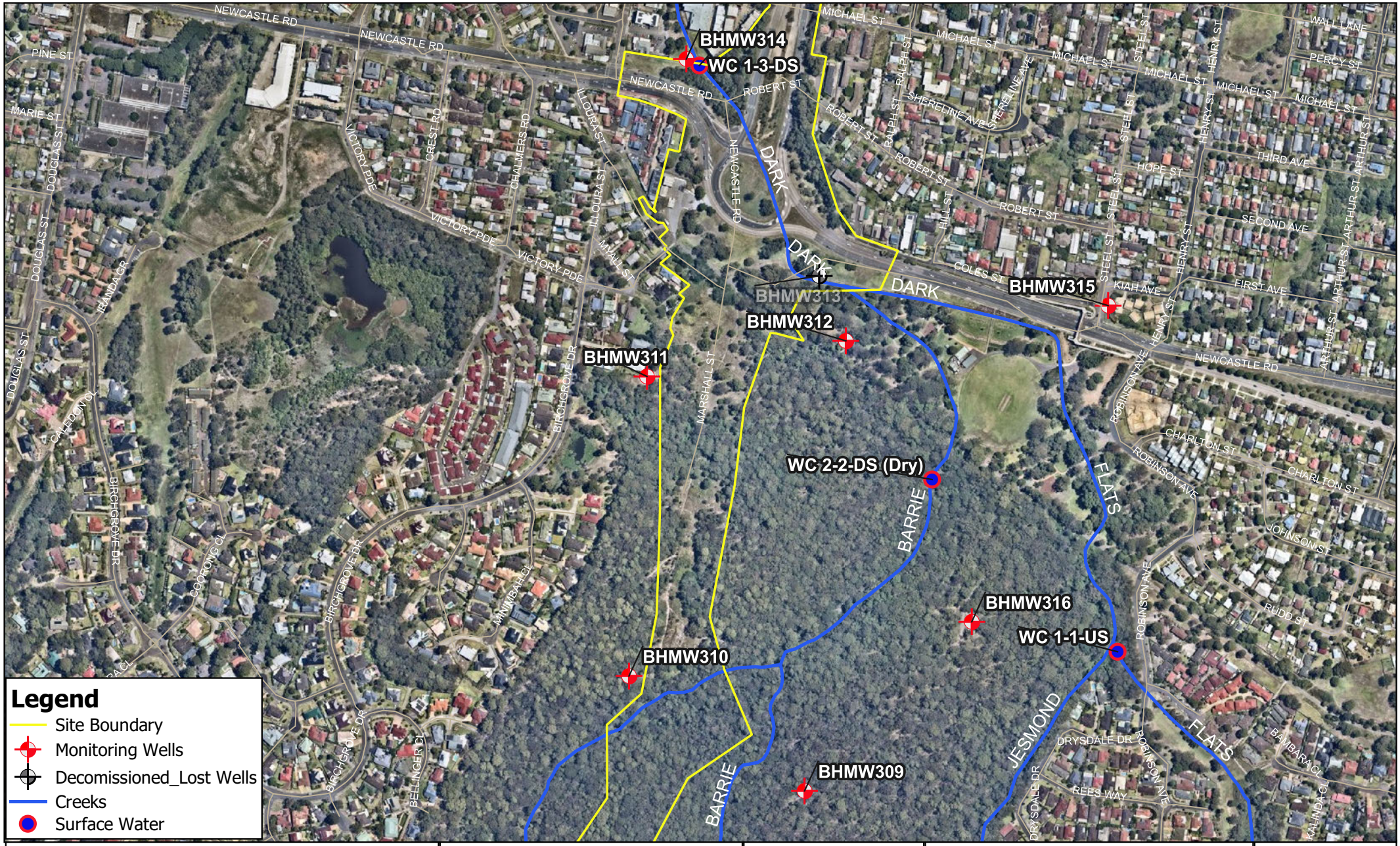

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Project Reference: 20234948	**NICB -Northern Water Monitoring Locations**
Date Drawn: 2023-07-26	
Drawn by: D. Kousbroek	
Data Source:Nearmap	NICB - Water Monitoring Program

Figure: **4**

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APPENDIX B ANALYTICAL RESULTS TABLES

Table 1
Groundwater - Inorganics and Nutrients

Analyte		Anions and Cations						
		Nitrite as N	Nitrate	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Nitrogen	Total suspended solids	Phosphate Total (as P)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05
NICB GW Maximum (Pre-Construction)		--	--	--	--	14	2,200	9.9
Sample Name	Sample Date							
BH307	27-Feb-23	-	-	< 0.05	**2.2**	**2.2**	**2,200**	**0.16**
BH310	27-Feb-23	-	-	**0.06**	**0.4**	**0.46**	**60**	**0.06**
BH321	29-Mar-23	-	-	< 0.05	< 0.2	< 0.2	**200**	**0.07**
BHMW303	24-Feb-23	-	-	**0.18**	**0.4**	**0.58**	**200**	**0.1**
	17-May-23	< 0.02	**0.05**	< 0.05	**0.2**	**0.2**	**170**	**0.06**
BHMW305	27-Feb-23	-	-	< 0.05	< 0.2	< 0.1	**13**	**0.22**
BHMW308	27-Feb-23	-	-	**0.07**	**1.1**	**1.17**	**970**	**0.3**
	24-Aug-23	< 0.02	**0.1**	**0.12**	< 0.2	< 0.2	**2,400**	**0.09**
	17-Nov-23	< 0.02	**0.07**	**0.07**	**0.4**	**0.5**	**220**	**0.11**
BHMW309	23-Feb-23	-	-	< 0.05	**2.1**	**2.1**	**190**	**0.46**
	24-Aug-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.2	**2,700**	**0.31**
	17-Nov-23	< 0.02	< 0.02	< 0.05	**1.0**	**1.0**	**1,100**	**0.89**
BHMW312	27-Feb-23	-	-	**0.23**	**0.8**	**1.03**	**7.7**	**3.9**
	18-May-23	< 0.02	< 0.02	< 0.05	**0.8**	**0.8**	**370**	**0.14**
	24-Aug-23	< 0.02	< 0.02	< 0.05	**1.7**	**1.7**	**43**	**0.03**
	17-Nov-23	< 0.02	< 0.02	< 0.05	**1.7**	**1.7**	**24**	**0.01**
BHMW313	23-Feb-23	-	-	< 0.05	**1.1**	**1.1**	< 5.0	**0.05**
BHMW314	23-Feb-23	-	-	< 0.05	**1.4**	**1.4**	**8.9**	**0.62**
	17-May-23	< 0.02	**0.02**	< 0.05	**0.9**	**0.9**	**24**	**0.22**
	24-Aug-23	< 0.02	**0.23**	**0.23**	**1.4**	**1.63**	**22**	**0.24**
	16-Nov-23	< 0.02	< 0.02	< 0.05	**1.2**	**1.2**	**17**	**0.3**
BHMW315	23-Feb-23	-	-	< 0.05	**1.0**	**1.0**	**20**	**0.04**
	17-May-23	< 0.02	**1.0**	**1.0**	**0.5**	**1.5**	< 5.0	**0.03**
	25-Aug-23	< 0.02	< 0.02	< 0.05	**0.4**	**0.4**	**9.2**	**0.05**
	16-Nov-23	< 0.02	**0.05**	**0.05**	**0.7**	**0.8**	**6.1**	**0.02**
BHMW316	23-Feb-23	-	-	< 0.05	< 0.2	< 0.1	**6.5**	**0.06**
	18-May-23	< 0.02	**0.03**	< 0.05	**0.8**	**0.8**	**11**	**0.12**
	24-Aug-23	< 0.02	< 0.02	< 0.05	**1.8**	**1.8**	**11**	**0.19**
	17-Nov-23	< 0.02	< 0.02	< 0.05	**1.1**	**1.1**	**26**	**0.07**
BHMW317	27-Feb-23	-	-	**0.14**	**6.6**	**6.74**	**170**	**0.64**
	18-May-23	< 0.02	**0.14**	**0.14**	**2.6**	**2.74**	**8.0**	**0.03**
	20-Aug-23	< 0.02	< 0.02	< 0.05	**0.2**	**0.2**	**47**	**0.02**
	17-Nov-23	< 0.02	< 0.02	< 0.05	**0.4**	**0.4**	**10**	**0.01**
BHMW318	29-Mar-23	-	-	**0.26**	< 0.2	**0.26**	**1,100**	**3.0**
	17-May-23	< 0.02	**0.04**	< 0.05	< 0.2	< 0.2	**8.4**	**0.95**
	20-Aug-23	< 0.02	**0.09**	**0.1**	**0.5**	**0.6**	**190**	**2.4**
	17-Nov-23	< 0.02	**0.02**	< 0.05	**0.3**	**0.3**	**180**	**2.6**

Notes:
- - Not analysed
< - Less than laboratory limit of reporting
mg/L - Milligrams per litre
Bold indicates a detection above the laboratory limit of reporting
Highlighting indicates an exceedance of the corresponding criteria (highlighting corresponds to the guideline with the highest criteria value where analytical result exceeds more than one guideline)

Criteria:
Newcastle Inner City Bypass - Rankin Park to Jesmond - Surface and Ground Water Quality Construction Monitoring Program June 2022 (Table 12)

Table 2
Groundwater - Dissolved Metals

Analyte		Metals											
		Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
NICB GW Maximum (Pre-Construction)		0.97	0.063	0.35	0.0029	0.88	0.44	10	0.24	5.8	0.0015	0.37	1.1
Sample Name	Sample Date												
BH307	27-Feb-23	**0.58**	**0.001**	< 0.05	**0.0006**	< 0.001	**0.031**	**4.7**	**0.002**	**0.44**	< 0.0001	**0.15**	**0.3**
BH310	27-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**7.7**	< 0.001	**0.4**	< 0.0001	**0.038**	**0.049**
BH321	29-Mar-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.004**	**0.15**	< 0.001	**1.0**	< 0.0001	**0.037**	**0.074**
BHMW303	24-Feb-23	**0.24**	**0.002**	< 0.05	**0.0002**	< 0.001	< 0.001	**2.8**	< 0.001	**4.8**	< 0.0001	**0.14**	**0.18**
	17-May-23	**0.26**	**0.006**	**0.16**	**0.0004**	< 0.001	**0.003**	**5.1**	< 0.001	**5.0**	< 0.0001	**0.14**	**0.24**
BHMW305	27-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**2.1**	< 0.001	**0.26**	< 0.0001	**0.013**	**0.012**
BHMW308	27-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.05**	< 0.001	**0.029**	< 0.0001	**0.014**	**0.009**
	24-Aug-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.003**	**1.2**	< 0.001	**0.044**	< 0.0001	**0.002**	**0.013**
	17-Nov-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.003**	**0.54**	< 0.001	**0.023**	< 0.0001	< 0.001	**0.008**
BHMW309	23-Feb-23	**0.12**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.023**	**0.23**	< 0.001	**0.14**	< 0.0001	**0.017**	**0.034**
	24-Aug-23	< 0.05	**0.001**	**0.07**	< 0.0002	< 0.001	**0.004**	**1.1**	**0.014**	**0.72**	< 0.0001	**0.008**	**0.021**
	17-Nov-23	< 0.05	**0.002**	**0.06**	< 0.0002	< 0.001	**0.001**	**2.9**	< 0.001	**0.79**	< 0.0001	**0.015**	**0.014**
BHMW312	27-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.001**	**0.12**	< 0.001	**0.12**	< 0.0001	**0.011**	**0.017**
	18-May-23	< 0.05	**0.001**	**0.15**	< 0.0002	< 0.001	< 0.001	**1.3**	< 0.001	**0.16**	< 0.0001	**0.015**	< 0.005
	24-Aug-23	< 0.05	< 0.001	**0.11**	< 0.0002	< 0.001	< 0.001	**0.68**	< 0.001	**0.058**	< 0.0001	**0.008**	< 0.005
	17-Nov-23	< 0.05	< 0.001	**0.12**	< 0.0002	< 0.001	**0.007**	< 0.05	< 0.001	**0.053**	< 0.0001	**0.004**	**0.024**
BHMW313	23-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.66**	< 0.001	**0.013**	< 0.0001	**0.002**	**0.007**
BHMW314	23-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.006**	**2.9**	< 0.001	**0.34**	< 0.0001	**0.016**	**0.017**
	17-May-23	< 0.05	< 0.001	**0.08**	< 0.0002	< 0.001	**0.002**	**2.4**	< 0.001	**0.31**	< 0.0001	**0.011**	**0.021**
	24-Aug-23	< 0.05	< 0.001	**0.08**	< 0.0002	< 0.001	**0.004**	**1.4**	< 0.001	**0.3**	< 0.0001	**0.014**	**0.034**
	16-Nov-23	< 0.05	< 0.001	**0.08**	< 0.0002	< 0.001	< 0.001	**2.6**	< 0.001	**0.33**	< 0.0001	**0.019**	**0.017**
BHMW315	23-Feb-23	< 0.05	**0.004**	< 0.05	< 0.0002	**0.001**	**0.005**	**3.3**	< 0.001	**0.23**	< 0.0001	**0.023**	**0.042**
	17-May-23	< 0.05	**0.025**	**0.19**	< 0.0002	< 0.001	< 0.001	**5.8**	< 0.001	**0.055**	< 0.0001	**0.039**	**0.04**
	25-Aug-23	< 0.05	**0.019**	**0.24**	< 0.0002	**0.002**	< 0.001	**4.7**	< 0.001	**0.033**	< 0.0001	**0.005**	**0.051**
	16-Nov-23	< 0.05	**0.023**	**0.21**	< 0.0002	**0.001**	**0.002**	**6.1**	< 0.001	**0.033**	< 0.0001	**0.007**	**0.016**
BHMW316	23-Feb-23	< 0.05	**0.003**	< 0.05	< 0.0002	< 0.001	< 0.001	**3.2**	< 0.001	**0.95**	< 0.0001	**0.013**	**0.014**
	18-May-23	< 0.05	**0.003**	**0.2**	< 0.0002	< 0.001	< 0.001	**5.0**	< 0.001	**0.84**	< 0.0001	**0.026**	**0.006**
	24-Aug-23	< 0.05	**0.002**	**0.16**	< 0.0002	< 0.001	< 0.001	**4.2**	< 0.001	**0.76**	< 0.0001	**0.031**	**0.005**
	17-Nov-23	< 0.05	**0.002**	**0.16**	< 0.0002	**0.001**	< 0.001	**3.4**	< 0.001	**0.84**	< 0.0001	**0.011**	**0.012**
BHMW317	27-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.003**	**0.05**	< 0.001	**0.022**	< 0.0001	**0.002**	**0.006**
	18-May-23	< 0.05	< 0.001	**0.1**	< 0.0002	< 0.001	< 0.001	**0.43**	< 0.001	**0.32**	< 0.0001	**0.004**	**0.008**
	20-Aug-23	< 0.05	< 0.001	**0.07**	< 0.0002	< 0.001	< 0.001	**2.0**	< 0.001	**0.2**	< 0.0001	< 0.001	< 0.005
	17-Nov-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	< 0.001	**1.5**	< 0.001	**0.18**	< 0.0001	**0.009**	< 0.005
BHMW318	29-Mar-23	< 0.05	< 0.001	**0.08**	< 0.0002	< 0.001	**0.005**	**0.11**	< 0.001	**0.13**	< 0.0001	**0.004**	**0.007**
	17-May-23	< 0.05	< 0.001	**0.09**	< 0.0002	< 0.001	< 0.001	**3.2**	< 0.001	**0.9**	< 0.0001	**0.011**	**0.018**
	20-Aug-23	< 0.05	< 0.001	**0.12**	< 0.0002	< 0.001	**0.001**	**1.0**	< 0.001	**0.59**	< 0.0001	**0.014**	**0.033**
	17-Nov-23	< 0.05	< 0.001	**0.11**	< 0.0002	< 0.001	**0.002**	**1.8**	< 0.001	**0.69**	< 0.0001	**0.006**	**0.011**

Notes:
- - Not analysed
< - Less than laboratory limit of reporting
mg/L - Milligrams per litre
Bold indicates a detection above the laboratory limit of reporting
Highlighting indicates an exceedance of the corresponding criteria (highlighting corresponds to the guideline with the highest criteria value where analytical result exceeds more than one guideline)

Criteria:
Newcastle Inner City Bypass - Rankin Park to Jesmond - Surface and Ground Water Quality Construction Monitoring Program June 2022 (Table 12)

Table 3
Surface water - Inorganics and Nutrients

Analyte		Anions and Cations						Anions and Cations	
		Nitrite as N	Nitrate	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Nitrogen	Total suspended solids	Total Phosphorus	Phosphate Total (as P)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 1-1-US Historical range		--	--	--	--	1.48	91	0.28	
Sample Name	Sample Date								
WC1-1-US	23-Feb-23	-	-	**0.18**	**1.3**	**1.48**	**91**	-	**0.05**
	28-Mar-23	-	-	**0.25**	< 0.2	**0.25**	< 5.0	-	**0.05**
	21-Apr-23	-	-	**0.02**	**0.6**	**0.6**	**16**	**0.07**	-
	19-May-23	< 0.02	**0.19**	**0.19**	< 0.2	< 0.2	**53**	-	**0.05**
	30-Jun-23	-	-	**0.18**	**0.2**	**0.38**	**28**	-	**0.04**
	26-Jul-23	< 0.02	**0.12**	**0.12**	< 0.2	< 0.1	< 5.0	-	**0.15**
	08-Aug-23	< 0.02	**0.16**	**0.16**	**0.8**	**0.96**	**14**	-	**0.04**
	24-Aug-23	< 0.02	**0.09**	**0.11**	< 0.2	< 0.2	**5.4**	-	**0.03**
	28-Sep-23	< 0.02	< 0.02	< 0.05	< 0.2	**0.5**	**46**	-	**0.05**
	25-Oct-23	< 0.02	**0.02**	< 0.05	**2.3**	**2.3**	**1,000**	-	**0.09**
	06-Nov-23	< 0.02	**0.33**	**0.34**	**0.3**	**0.6**	**17**	-	**0.02**
	27-Oct-23	**0.24**	**0.24**	**0.49**	< 0.2	**0.5**	-	-	**0.04**
	17-Nov-23	< 0.02	**0.05**	< 0.05	**0.6**	**0.6**	< 5.0	-	**0.03**
	18-Dec-23	< 0.02	< 0.02	< 0.05	**0.8**	**0.8**	**9.5**	-	**0.07**
	17-Jan-24	< 0.02	**0.03**	< 0.05	**0.5**	**0.5**	**9.2**	-	**0.05**
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 1-3-DS Historical range		--	--	--	--	3.8	130	0.6	
WC 1-3-DS	23-Feb-23	-	-	**0.45**	**0.7**	**1.15**	**130**	-	**0.1**
	28-Mar-23	-	-	**0.43**	**1.6**	**2.03**	**250**	-	**0.02**
	21-Apr-23	-	-	**0.57**	**0.8**	**1.4**	**50**	**0.08**	-
	19-May-23	< 0.02	**0.53**	**0.53**	**0.7**	**1.23**	**12**	-	**0.06**
	30-Jun-23	-	-	**0.64**	**0.2**	**0.84**	**6.0**	**-**	**0.08**
	26-Jul-23	**0.02**	**0.4**	**0.42**	**1.8**	**2.22**	< 5.0	-	**0.18**
	08-Aug-23	< 0.02	**1.3**	**1.3**	**1.1**	**2.4**	**27**	-	**0.06**
	24-Aug-23	< 0.02	**0.82**	**0.84**	< 0.2	**0.84**	**9.4**	-	**0.06**
	28-Sep-23	< 0.02	< 0.02	< 0.05	< 0.2	**0.9**	**22**	-	**0.1**
	25-Oct-23	< 0.02	**0.28**	**0.28**	**4.5**	**4.8**	**12**	-	**0.01**
	27-Oct-23	**0.04**	**0.28**	**0.31**	< 0.2	**0.3**	-	-	**0.04**
	06-Nov-23	< 0.02	**1.1**	**1.1**	**0.9**	**2.0**	**19**	-	**0.05**
	17-Nov-23	< 0.02	**1.1**	**1.1**	**0.5**	**1.6**	**8.0**	-	**0.06**
	18-Dec-23	< 0.02	**0.47**	**0.47**	< 0.2	**0.5**	< 5.0	-	**0.03**
	17-Jan-24	< 0.02	**0.38**	**0.39**	**0.6**	**1.0**	< 5.0	-	**0.07**
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 2-2-DS Historical range		--	--	--	--	--	--	--	--
WC2-2-DS	06-Nov-23	< 0.02	**0.06**	**0.06**	**3.6**	**3.7**	**260**	-	**0.22**
	17-Nov-23	< 0.02	**0.03**	< 0.05	< 0.2	< 0.2	**55**	-	**0.35**
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 3-2-DS Historical range		--	--	--	--	1.7	130	0.17	
WC 3-2-DS	24-Feb-23	-	-	**0.1**	< 0.2	< 0.1	**130**	-	**0.02**
	28-Mar-23	-	-	< 0.05	**9.3**	**9.3**	**30**	-	**0.03**
	21-Apr-23	-	-	< 0.01	**2.1**	**2.1**	**143**	**0.1**	-
	19-May-23	< 0.02	**0.89**	**0.89**	**0.4**	**1.29**	**100**	-	**0.1**
	24-Aug-23	< 0.02	**0.12**	**0.13**	< 0.2	< 0.2	**16**	-	< 0.01

Table 3
Surface water - Inorganics and Nutrients

Analyte		Anions and Cations						Anions and Cations	
		Nitrite as N	Nitrate	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Nitrogen	Total suspended solids	Total Phosphorus	Phosphate Total (as P)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	27-Oct-23	**0.03**	**0.21**	**0.24**	**1.4**	**1.6**	-	-	**0.06**
	06-Nov-23	< 0.02	**0.95**	**0.95**	**1.7**	**2.7**	**98**	-	**0.04**
	17-Nov-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.2	**210**	-	**0.03**
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 4-1-US Historical range		--	--	--	--	1.7	14	0.14	
WC4-1-US	24-Feb-23	-	-	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.01**
	28-Mar-23	-	-	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.02**
	21-Apr-23	-	-	**0.02**	**0.4**	**0.4**	< 5.0	**0.04**	-
	19-May-23	< 0.02	**0.16**	**0.16**	< 0.2	< 0.2	< 5.0	-	**0.02**
	30-Jun-23	-	-	**0.21**	**1.0**	**1.21**	< 5.0	-	< 0.01
	26-Jul-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.89**
	08-Aug-23	< 0.02	< 0.02	< 0.05	**0.5**	**0.5**	**12**	-	< 0.01
	25-Aug-23	< 0.02	< 0.02	< 0.05	**8.9**	**8.9**	< 5.0	-	< 0.01
	28-Sep-23	< 0.02	< 0.02	< 0.05	< 0.2	**0.3**	< 5.0	-	**0.02**
	25-Oct-23	< 0.02	< 0.02	< 0.05	**1.8**	**1.8**	< 5.0	-	< 0.01
	27-Oct-23	< 0.02	**0.36**	**0.37**	**1.1**	**1.5**	-	-	**0.01**
	06-Nov-23	< 0.02	**0.03**	< 0.05	**0.3**	**0.3**	**6.4**	-	**0.01**
	17-Nov-23	< 0.02	**0.09**	**0.1**	< 0.2	< 0.2	< 5.0	-	< 0.01
	18-Dec-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.2	< 5.0	-	< 0.01
	17-Jan-24	< 0.02	< 0.02	< 0.05	**0.4**	**0.4**	< 5.0	-	< 0.01
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 4-2-DS Historical range		--	--	--	--	1.6	12	0.1	
WC 4-2-DS	24-Feb-23	-	-	< 0.05	**0.3**	**0.3**	< 5.0	-	**0.02**
	28-Mar-23	-	-	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.03**
	21-Apr-23	-	-	**0.03**	**1.0**	**1.0**	< 5.0	**0.01**	-
	19-May-23	< 0.02	**0.04**	< 0.05	**0.3**	**0.3**	**15**	-	**0.02**
	30-Jun-23	-	-	**0.06**	**0.2**	**0.26**	< 5.0	**-**	< 0.01
	26-Jul-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.1	**25**	-	**0.02**
	08-Aug-23	< 0.02	**0.03**	< 0.05	**0.8**	**0.8**	**9.1**	-	**0.06**
	25-Aug-23	< 0.02	< 0.02	< 0.05	**5.0**	**5.0**	**20**	-	< 0.01
	28-Sep-23	< 0.02	< 0.02	< 0.05	< 0.2	**0.8**	**95**	-	**0.04**
	25-Oct-23	< 0.02	< 0.02	< 0.05	**1.5**	**1.5**	**24**	-	< 0.01
	27-Oct-23	< 0.02	**0.21**	**0.21**	**0.8**	**1.0**	-	-	**0.02**
	06-Nov-23	< 0.02	**0.19**	**0.19**	**0.5**	**0.7**	**19**	-	**0.02**
	17-Nov-23	< 0.02	**0.02**	< 0.05	**0.3**	**0.3**	< 5.0	-	< 0.01
	18-Dec-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.2	**8.4**	-	< 0.01
	17-Jan-24	< 0.02	< 0.02	< 0.05	< 0.2	< 0.2	**22**	-	< 0.01
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 4-3-US Historical range		--	--	--	--	1.8	26	0.81	
WC 4-3-US	24-Feb-23	-	-	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.05**
	28-Mar-23	-	-	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.03**
	21-Apr-23	-	-	**0.04**	**0.7**	**0.7**	**8.0**	**0.04**	-
	19-May-23	< 0.02	**2.3**	**2.3**	< 0.2	**2.3**	< 5.0	-	**0.04**
	26-Jul-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.1	**28**	-	**0.3**
	08-Aug-23	< 0.02	**0.09**	**0.1**	**0.5**	**0.6**	< 5.0	-	**0.29**
	25-Aug-23	< 0.02	**0.31**	**0.31**	< 0.2	**0.31**	**5.6**	-	**0.01**
	27-Oct-23	**0.23**	**0.49**	**0.72**	**4.0**	**4.7**	-	-	**0.03**

Table 3
Surface water - Inorganics and Nutrients

Analyte		Anions and Cations						Anions and Cations	
		Nitrite as N	Nitrate	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Nitrogen	Total suspended solids	Total Phosphorus	Phosphate Total (as P)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	06-Nov-23	**-0.0004**	**0.08**	**0.08**	**0.3**	**0.4**	**7.8**	-	**0.04**
	17-Nov-23	< 0.02	< 0.02	< 0.05	**0.3**	**0.3**	< 5.0	-	**0.04**
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC 5-1-DS Historical range		--	--	--	--	1.7	<LOR	0.02	
WC 5-1-DS	24-Feb-23	-	-	**0.79**	< 0.2	**0.79**	< 5.0	-	**0.02**
	28-Mar-23	-	-	**0.26**	< 0.2	**0.26**	**23**	-	**0.03**
	21-Apr-23	-	-	**0.07**	**0.6**	**0.7**	**32**	**0.02**	-
	19-May-23	< 0.02	**0.13**	**0.13**	**0.9**	**1.03**	< 5.0	-	**0.02**
	30-Jun-23	-	-	**0.06**	**0.3**	**0.36**	< 5.0	**-**	**0.02**
	26-Jul-23	< 0.02	**0.06**	**0.06**	< 0.2	< 0.1	< 5.0	-	< 0.01
	08-Aug-23	< 0.02	**0.16**	**0.17**	**0.5**	**0.67**	**45**	-	**0.04**
	24-Aug-23	< 0.02	**0.03**	< 0.05	< 0.2	< 0.2	**7.7**	-	< 0.01
	06-Nov-23	**-0.00019**	**0.51**	**0.51**	**0.3**	**0.8**	**8.2**	-	**0.01**
	17-Nov-23	< 0.02	**0.04**	< 0.05	< 0.2	< 0.2	< 5.0	-	< 0.01
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC Blue Wren Ck-DS Historical range		--	--	--	--	3.3	16	0.21	
WC Blue Wren Ck-DS	24-Feb-23	-	-	**0.6**	< 0.2	**0.6**	**5.6**	-	**0.06**
	28-Mar-23	-	-	**0.77**	< 0.2	**0.77**	< 5.0	-	**0.06**
	21-Apr-23	-	-	**0.35**	**0.6**	**1.0**	**12**	**0.05**	-
	19-May-23	< 0.02	**0.4**	**0.41**	**0.2**	**0.61**	**5.1**	-	**0.05**
	30-Jun-23	-	-	**0.15***	**0.6***	**0.8***	**23**	-	**0.06**
	26-Jul-23	< 0.02	< 0.02	< 0.05	< 0.2	< 0.1	< 5.0	-	**0.08**
	08-Aug-23	**0.16**	**3.6**	**3.8**	**0.9**	**4.7**	**17**	-	**0.07**
	24-Aug-23	< 0.02	**0.14**	**0.14**	< 0.2	< 0.2	< 5.0	-	< 0.01
	28-Sep-23	< 0.02	< 0.02	< 0.05	< 0.2	**0.5**	**13**	-	**0.13**
	25-Oct-23	< 0.02	< 0.02	< 0.05	**2.1**	**2.1**	< 5.0	-	< 0.01
	27-Oct-23	< 0.02	**0.12**	**0.13**	**15**	**15**	-	-	**0.04**
	06-Nov-23	**-0.00021**	**1.1**	**1.1**	**0.4**	**1.5**	**35**	-	**0.03**
	17-Nov-23	< 0.02	**0.11**	**0.11**	**0.9**	**1.0**	< 5.0	-	**0.08**
	18-Dec-23	< 0.02	**0.02**	**0.03***	**0.9***	**0.9***	**12***	-	**0.06**
	17-Jan-24	< 0.02	< 0.02	< 0.05	**0.8**	**0.8**	**8.8**	-	**0.08**
NICB - Investigation Levels		--	--	--	--	0.5	--	0.05	0.05
WC Ironbark Ck-DS Historical range		--	--	--	--	2.7	28	0.34	
WC Ironbark Ck-DS	23-Feb-23	-	-	< 0.05	**0.8**	**0.8**	**21**	-	**0.17**
	28-Mar-23	-	-	**0.44**	< 0.2	**0.44**	**19**	-	**0.1**
	21-Apr-23	-	-	**0.33**	**0.9**	**1.2**	**46**	**0.11**	-
	19-May-23	< 0.02	**0.23**	**0.24**	< 0.2	**0.24**	**17**	-	**0.07**
	30-Jun-23	-	-	< 0.05	< 0.2	< 0.1	**36**	-	**0.02**
	26-Jul-23	< 0.02	**0.26**	**0.26**	**0.6**	**0.86**	**12**	-	**0.08**
	08-Aug-23	< 0.02	< 0.02	< 0.05	**1.8**	**1.8**	**11**	-	**0.53**
	24-Aug-23	< 0.02	**0.21**	**0.21**	**0.6**	**0.81**	**10**	-	< 0.01
	28-Sep-23	< 0.02	< 0.02	< 0.05	< 0.2	**0.3**	**42**	-	**0.15**
	25-Oct-23	< 0.02	**0.04**	< 0.05	**1.7**	**1.7**	**15**	-	**0.02**
	27-Oct-23	**0.04**	**0.21**	**0.25**	**0.7**	**1.0**	-	-	**0.01**
	06-Nov-23	< 0.02	**0.56**	**0.56**	**0.6**	**1.2**	**77**	-	**0.17**
	16-Nov-23	< 0.02	< 0.02	< 0.05	**1.5**	**1.5**	**17**	-	**0.22**
	18-Dec-23	< 0.02	< 0.02	< 0.05	**0.6**	**0.6**	**28**	-	**0.17**

Table 3
Surface water - Inorganics and Nutrients

Analyte		Anions and Cations						Anions and Cations	
		Nitrite as N	Nitrate	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Nitrogen	Total suspended solids	Total Phosphorus	Phosphate Total (as P)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	17-Jan-24	< 0.02	< 0.02	**0.01***	**1.3**	**1.3**	**40**	-	**0.06**

Notes:
- - Not analysed
< - Less than laboratory limit of reporting
mg/L - Milligrams per litre
µS/cm - Microsiemens per centimeter
mV - Millivolts
Bold indicates a detection above the laboratory limit of reporting
Highlighting indicates an exceedance of the corresponding criteria (highlighting corresponds to the guideline with the highest criteria value where analytical result exceeds more than one guideline)
"*" denotes duplicate/triplicate sample result adopted for analytical use due to RPD >50%

Criteria:
Newcastle Inner City Bypass - Rankin Park to Jesmond - Surface and Ground Water Quality Construction Monitoring Program June 2022 (Table 12)

Table 4
Surface water - Dissolved metals

Analyte		Metals											
		Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 1-1-US Historical range		0.14	<LOR	<LOR	<LOR	0.002	0.005	0.48	0.001	0.088	<LOR	0.002	0.037
Sample Name	Sample Date												
WC1-1-US	23-Feb-23	**0.07**	**0.001**	< 0.05	< 0.0002	< 0.001	**0.003**	**0.18**	< 0.001	**0.041**	< 0.0001	**0.001**	**0.013**
	28-Mar-23	**0.15**	**0.001**	< 0.05	< 0.0002	**0.002**	**0.004**	**0.24**	< 0.001	**0.013**	< 0.0001	< 0.001	**0.009**
	21-Apr-23	**0.02**	**0.002**	< 0.05	< 0.0001	< 0.001	**0.003**	**2.0**	< 0.001	**0.236**	< 0.0001	**0.001**	< 0.005
	19-May-23	**0.17**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.58**	< 0.001	**0.047**	< 0.0001	**0.001**	**0.006**
	30-Jun-23	< 0.05	**0.001**	**0.05**	< 0.0002	< 0.001	**0.003**	**1.6**	< 0.001	**0.22**	< 0.0001	< 0.001	**0.011**
	26-Jul-23	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	**0.001**	**1.1**	< 0.001	**0.12**	< 0.0001	< 0.001	**0.007**
	08-Aug-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.56**	< 0.001	**0.051**	< 0.0001	< 0.001	**0.01**
	24-Aug-23	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	**0.003**	**0.47**	< 0.001	**0.057**	< 0.0001	< 0.001	**0.009**
	28-Sep-23	< 0.05	**0.001**	**0.06**	< 0.0002	< 0.001	**0.007**	**0.3**	< 0.001	**0.036**	< 0.0001	**0.001**	**0.014**
	25-Oct-23	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	**0.005**	**4.0**	< 0.001	**0.75**	< 0.0001	< 0.001	< 0.005
	27-Oct-23	**0.08**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.55**	< 0.001	**0.057**	< 0.0001	**0.001**	**0.016**
	06-Nov-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.16**	< 0.001	**0.038**	< 0.0001	< 0.001	**0.015**
	17-Nov-23	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	**0.005**	**1.1**	< 0.001	**0.18**	< 0.0001	**0.001**	**0.006**
	18-Dec-23	< 0.05	**0.003**	**0.07**	< 0.0002	< 0.001	< 0.001	**4.0**	< 0.001	**0.46**	< 0.0001	**0.001**	< 0.005
	17-Jan-24	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	< 0.001	**1.8**	< 0.001	**0.14**	< 0.0001	< 0.001	< 0.005
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 1-3-DS Historical range		0.14	<LOR	<LOR	<LOR	0.002	0.004	0.29	<LOR	0.033	<LOR	0.011	0.059
WC 1-3-DS	23-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.07**	< 0.001	**0.018**	< 0.0001	**0.002**	**0.007**
	28-Mar-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.09**	< 0.001	**0.023**	< 0.0001	**0.002**	**0.015**
	21-Apr-23	**0.02**	< 0.001	< 0.05	< 0.0001	< 0.001	**0.003**	**0.13**	< 0.001	**0.017**	< 0.0001	**0.002**	< 0.005
	19-May-23	**0.09**	< 0.001	**0.06**	< 0.0002	< 0.001	**0.002**	**0.27**	< 0.001	**0.031**	< 0.0001	**0.003**	**0.013**
	30-Jun-23	< 0.05	< 0.001	**0.11**	**0.0004**	< 0.001	**0.001**	**0.16**	< 0.001	**0.01**	< 0.0001	**0.002**	**0.008**
	26-Jul-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.002**	**0.17**	< 0.001	**0.013**	< 0.0001	**0.003**	**0.01**
	08-Aug-23	< 0.05	**0.001**	**0.07**	**0.0002**	< 0.001	**0.003**	**0.21**	< 0.001	**0.069**	< 0.0001	**0.003**	**0.008**
	24-Aug-23	< 0.05	**0.001**	**0.06**	< 0.0002	< 0.001	**0.004**	**0.08**	< 0.001	**0.02**	< 0.0001	**0.002**	**0.007**
	28-Sep-23	**0.09**	**0.001**	**0.06**	< 0.0002	**0.002**	**0.003**	**0.32**	< 0.001	**0.036**	< 0.0001	**0.002**	**0.011**
	25-Oct-23	< 0.05	< 0.001	**0.05**	< 0.0002	< 0.001	**0.001**	**0.25**	< 0.001	< 0.005	< 0.0001	**0.001**	< 0.005
	27-Oct-23	**0.08**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.003**	**0.2**	< 0.001	**0.009**	< 0.0001	**0.001**	**0.006**
	06-Nov-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.005**	**0.06**	< 0.001	**0.024**	< 0.0001	< 0.001	**0.01**
	17-Nov-23	< 0.05	< 0.001	**0.08**	< 0.0002	**0.001**	**0.005**	**0.09**	< 0.001	**0.007**	< 0.0001	**0.002**	< 0.005
	18-Dec-23	< 0.05	< 0.001	**0.08**	< 0.0002	**0.001**	**0.001**	**0.21**	< 0.001	< 0.005	< 0.0001	**0.002**	< 0.005
	17-Jan-24	< 0.05	**0.001**	**0.08**	< 0.0002	< 0.001	**0.001**	**0.35**	< 0.001	**0.01**	< 0.0001	< 0.001	< 0.005
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 2-2-DS Historical range		--	--	--	--	--	--	--	--	--	--	--	--
WC2-2-DS	06-Nov-23	**0.24**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.08**	< 0.001	**0.071**	< 0.0001	< 0.001	**0.027**
	17-Nov-23	**0.38**	**0.004**	< 0.05	< 0.0002	< 0.001	**0.006**	**1.6**	**0.002**	**0.18**	< 0.0001	**0.006**	**0.02**
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 3-2-DS Historical range		1.0	<LOR	<LOR	<LOR	0.003	0.004	0.66	0.001	0.026	<LOR	0.002	0.025
WC 3-2-DS	24-Feb-23	**0.21**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.21**	< 0.001	**0.019**	< 0.0001	**0.002**	**0.015**
	28-Mar-23	**0.24**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.16**	< 0.001	**0.015**	< 0.0001	**0.002**	**0.017**
	21-Apr-23	**1.37**	**0.001**	< 0.05	< 0.0001	< 0.001	**0.002**	**0.61**	< 0.001	**0.073**	< 0.0001	**0.003**	**0.023**
	19-May-23	**0.25**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.007**	**0.33**	< 0.001	**0.014**	< 0.0001	**0.003**	**0.01**
	24-Aug-23	< 0.05	**0.001**	< 0.05	**0.0003**	< 0.001	< 0.001	< 0.05	< 0.001	**0.24**	< 0.0001	**0.007**	**0.049**
	27-Oct-23	**0.08**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.18**	< 0.001	**0.021**	< 0.0001	**0.003**	< 0.005
	06-Nov-23	**2.0**	**0.003**	< 0.05	**0.0002**	**0.002**	**0.009**	**1.5**	**0.006**	**0.39**	< 0.0001	**0.007**	**0.11**
	17-Nov-23	**0.69**	**0.001**	< 0.05	**0.0007**	< 0.001	**0.006**	**1.2**	**0.001**	**0.92**	< 0.0001	**0.012**	**0.24**
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 4-1-US Historical range		0.2	<LOR	<LOR	<LOR	0.001	0.001	1.6	<LOR	0.15	<LOR	0.002	0.011
	24-Feb-23	**0.07**	**0.001**	< 0.05	< 0.0002	< 0.001	< 0.001	**1.6**	< 0.001	**0.15**	< 0.0001	< 0.001	< 0.005
	28-Mar-23	**0.22**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.51**	< 0.001	**0.021**	< 0.0001	< 0.001	< 0.005
	21-Apr-23	**0.26**	< 0.001	< 0.05	< 0.0001	< 0.001	< 0.001	**0.35**	< 0.001	**0.019**	< 0.0001	< 0.001	< 0.005
	19-May-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.63**	< 0.001	**0.044**	< 0.0001	< 0.001	< 0.005

Table 4
Surface water - Dissolved metals

Analyte		Metals											
		Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
WC4-1-US	30-Jun-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.29**	< 0.001	**0.022**	< 0.0001	< 0.001	< 0.005
	26-Jul-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.61**	< 0.001	**0.05**	< 0.0001	**0.001**	**0.01**
	08-Aug-23	< 0.05	< 0.001	< 0.05	**0.0002**	< 0.001	< 0.001	**0.13**	< 0.001	**0.01**	< 0.0001	< 0.001	< 0.005
	25-Aug-23	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	< 0.001	**1.4**	< 0.001	**0.089**	< 0.0001	< 0.001	< 0.005
	28-Sep-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.2**	< 0.001	**0.021**	< 0.0001	< 0.001	**0.006**
	25-Oct-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.24**	< 0.001	**0.02**	< 0.0001	< 0.001	< 0.005
	27-Oct-23	< 0.05	< 0.001	< 0.05	< 0.0002	**0.001**	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
	06-Nov-23	**0.23**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.001**	**0.67**	< 0.001	**0.053**	< 0.0001	< 0.001	< 0.005
	17-Nov-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.38**	< 0.001	**0.039**	< 0.0001	< 0.001	< 0.005
	18-Dec-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.35**	< 0.001	**0.048**	< 0.0001	< 0.001	< 0.005
	17-Jan-24	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.47**	< 0.001	**0.037**	< 0.0001	< 0.001	< 0.005
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 4-2-DS Historical range		0.4	<LOR	<LOR	<LOR	0.002	0.002	1.14	<LOR	0.231	<LOR	0.003	0.036
WC 4-2-DS	24-Feb-23	**0.07**	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.57**	< 0.001	**0.067**	< 0.0001	< 0.001	**0.006**
	28-Mar-23	**0.3**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.76**	< 0.001	**0.048**	< 0.0001	< 0.001	**0.008**
	21-Apr-23	**0.36**	< 0.001	< 0.05	< 0.0001	< 0.001	< 0.001	**0.72**	< 0.001	**0.037**	< 0.0001	< 0.001	< 0.005
	19-May-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.2**	< 0.001	**0.036**	< 0.0001	< 0.001	**0.007**
	30-Jun-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.34**	< 0.001	**0.074**	< 0.0001	< 0.001	< 0.005
	26-Jul-23	**0.06**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.19**	< 0.001	**0.042**	< 0.0001	< 0.001	< 0.005
	08-Aug-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.19**	< 0.001	**0.048**	< 0.0001	< 0.001	< 0.005
	25-Aug-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.08**	< 0.001	**0.043**	< 0.0001	< 0.001	< 0.005
	28-Sep-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.1**	< 0.001	**0.053**	< 0.0001	**0.001**	**0.006**
	25-Oct-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.22**	< 0.001	**0.042**	< 0.0001	< 0.001	< 0.005
	27-Oct-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.001**	< 0.05	< 0.001	< 0.005	< 0.0001	**0.001**	< 0.005
	06-Nov-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.07**	< 0.001	**0.11**	< 0.0001	< 0.001	**0.008**
	17-Nov-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.16**	< 0.001	**0.12**	< 0.0001	**0.004**	**0.016**
	18-Dec-23	< 0.05	< 0.001	0.06	< 0.0002	< 0.001	0.004	**0.09**	< 0.001	**0.041**	< 0.0001	**0.001**	< 0.005
	17-Jan-24	< 0.05	< 0.001	< 0.05	**0.0002**	< 0.001	< 0.001	< 0.05	< 0.001	**0.23**	< 0.0001	**0.025**	**0.079**
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 4-3-US Historical range		0.42	<LOR	<LOR	<LOR	0.003	0.002	0.79	<LOR	0.438	<LOR	0.002	0.015
WC 4-3-US	24-Feb-23	**0.08**	**0.001**	< 0.05	< 0.0002	< 0.001	< 0.001	**0.51**	< 0.001	**0.068**	< 0.0001	**0.001**	**0.006**
	28-Mar-23	**0.07**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.003**	**0.33**	< 0.001	**0.032**	< 0.0001	**0.001**	**0.009**
	21-Apr-23	**0.12**	< 0.001	**0.05**	< 0.0001	< 0.001	**0.002**	**0.44**	< 0.001	**0.03**	< 0.0001	**0.001**	**0.005**
	19-May-23	**0.12**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.38**	< 0.001	**0.042**	< 0.0001	**0.001**	< 0.005
	26-Jul-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.003**	**3.8**	< 0.001	**0.73**	< 0.0001	**0.003**	< 0.005
	08-Aug-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.001**	< 0.05	< 0.001	**0.008**	< 0.0001	< 0.001	**0.014**
	25-Aug-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.18**	< 0.001	**0.096**	< 0.0001	**0.001**	**0.014**
	27-Oct-23	**0.28**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.37**	< 0.001	**0.17**	< 0.0001	**0.002**	**0.016**
	06-Nov-23	**0.24**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.005**	**0.31**	**0.001**	**0.008**	< 0.0001	< 0.001	**0.021**
	17-Nov-23	**0.06**	**0.001**	< 0.05	< 0.0002	< 0.001	**0.003**	**0.2**	< 0.001	**0.091**	< 0.0001	**0.002**	**0.016**
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC 5-1-DS Historical range		0.29	<LOR	0.07	<LOR	0.002	0.003	0.23	0.001	0.026	<LOR	0.001	0.033
WC 5-1-DS	24-Feb-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.07**	< 0.001	**0.026**	< 0.0001	**0.001**	**0.033**
	28-Mar-23	< 0.05	< 0.001	**0.07**	< 0.0002	< 0.001	**0.002**	**0.18**	< 0.001	**0.025**	< 0.0001	< 0.001	**0.018**
	21-Apr-23	**0.02**	< 0.001	**0.05**	< 0.0001	< 0.001	**0.002**	**0.16**	< 0.001	**0.048**	< 0.0001	**0.001**	**0.01**
	19-May-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.001**	**0.17**	< 0.001	**0.039**	< 0.0001	**0.001**	**0.016**
	30-Jun-23	< 0.05	< 0.001	**0.07**	< 0.0002	< 0.001	**0.001**	**0.31**	< 0.001	**0.16**	< 0.0001	**0.001**	**0.014**
	26-Jul-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	**0.08**	< 0.001	**0.053**	< 0.0001	**0.001**	**0.012**
	08-Aug-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.004**	**0.05**	< 0.001	**0.032**	< 0.0001	**0.001**	**0.013**
	24-Aug-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	< 0.001	**0.11**	< 0.001	**0.056**	< 0.0001	**0.001**	**0.013**
	06-Nov-23	**0.06**	< 0.001	**0.06**	< 0.0002	< 0.001	**0.002**	**0.08**	< 0.001	**0.007**	< 0.0001	< 0.001	**0.031**
	17-Nov-23	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	**0.002**	< 0.05	< 0.001	**0.041**	< 0.0001	**0.001**	**0.039**
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC Blue Wren Ck-DS Historical range		0.11	0.002	0.06	<LOR	0.002	0.004	2.3	0.002	0.36	<LOR	0.001	0.098
	24-Feb-23	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	< 0.001	**2.3**	< 0.001	**0.36**	< 0.0001	**0.001**	**0.098**

Table 4
Surface water - Dissolved metals

Analyte		Metals											
		Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
WC Blue Wren Ck-DS	28-Mar-23	< 0.05	**0.002**	**0.06**	< 0.0002	< 0.001	**0.005**	**0.3**	< 0.001	**0.043**	< 0.0001	< 0.001	**0.038**
	21-Apr-23	**0.08**	**0.001**	< 0.05	< 0.0001	< 0.001	**0.004**	**0.18**	< 0.001	**0.036**	< 0.0001	< 0.001	**0.022**
	19-May-23	**0.2**	**0.001**	< 0.05	< 0.0002	< 0.001	**0.004**	**0.83**	< 0.001	**0.084**	< 0.0001	< 0.001	**0.03**
	30-Jun-23	< 0.05	**0.002**	< 0.05	< 0.0002	**0.002***	< 0.001	**7.4**	< 0.001	**0.98**	< 0.0001	< 0.001	< 0.005
	26-Jul-23	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	< 0.001	**4.0**	< 0.001	**0.4**	< 0.0001	< 0.001	**0.008**
	08-Aug-23	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	**0.003**	**3.5**	< 0.001	**0.35**	< 0.0001	< 0.001	**0.013**
	24-Aug-23	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	**0.003**	**0.78**	< 0.001	**0.12**	< 0.0001	< 0.001	**0.033**
	28-Sep-23	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	**0.003**	**0.27**	**0.001**	**0.046**	< 0.0001	< 0.001	**0.024**
	25-Oct-23	< 0.05	**0.004**	< 0.05	< 0.0002	< 0.001	< 0.001	**6.8**	< 0.001	**0.37**	< 0.0001	< 0.001	< 0.005
	27-Oct-23	**0.06**	< 0.001	< 0.05	< 0.0002	< 0.001	**0.003**	**0.14**	< 0.001	**0.014**	< 0.0001	< 0.001	**0.018**
	06-Nov-23	**0.18**	**0.002**	< 0.05	< 0.0002	< 0.001	**0.004**	**0.34**	< 0.001	**0.057**	< 0.0001	< 0.001	**0.027**
	17-Nov-23	< 0.05	**0.003**	< 0.05	< 0.0002	< 0.001	< 0.001	**5.1**	< 0.001	**0.49**	< 0.0001	< 0.001	**0.006**
	18-Dec-23	< 0.05	**0.003**	0.06	< 0.0002	< 0.001	< 0.001	**6.5**	< 0.001	**0.57**	< 0.0001	< 0.001	< 0.005
	17-Jan-24	< 0.05	**0.003**	**0.07**	< 0.0002	< 0.001	< 0.001	**4.3**	< 0.001	**0.34**	< 0.0001	< 0.001	< 0.005
NICB - Investigation Levels		0.08	0.042	0.68	0.0004	0.006	0.0018	--	0.0056	2.5	0.0019	0.013	0.015
WC Ironbark Ck-DS Historical range		0.09	0.001	0.08	0.0002	0.002	0.004	0.93	0.001	1.0	<LOR	0.007	0.067
WC Ironbark Ck-DS	23-Feb-23	**0.11**	**0.003**	< 0.05	**0.0002**	< 0.001	**0.002**	**0.3**	< 0.001	**1.0**	< 0.0001	**0.007**	**0.054**
	28-Mar-23	< 0.05	**0.002**	**0.08**	< 0.0002	< 0.001	**0.005**	**0.22**	< 0.001	**0.28**	< 0.0001	**0.003**	**0.024**
	21-Apr-23	**0.21**	< 0.001	< 0.05	< 0.0001	< 0.001	**0.004**	**0.16**	< 0.001	**0.065**	< 0.0001	**0.001**	**0.016**
	19-May-23	< 0.05	< 0.001	**0.39**	< 0.0002	< 0.001	**0.002**	**0.1**	< 0.001	**0.19**	< 0.0001	**0.002**	**0.013**
	30-Jun-23	< 0.05	< 0.001	**1.7**	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	**0.28**	< 0.0001	**0.002**	**0.009**
	26-Jul-23	< 0.05	< 0.001	**0.38**	< 0.0002	< 0.001	< 0.001	**0.09**	< 0.001	**0.4**	< 0.0001	**0.002**	**0.009**
	08-Aug-23	< 0.05	**0.004**	**0.16**	< 0.0002	< 0.001	< 0.001	**0.76**	< 0.001	**0.47**	< 0.0001	**0.001**	< 0.005
	24-Aug-23	< 0.05	< 0.001	**0.95**	< 0.0002	< 0.001	< 0.001	**0.07**	< 0.001	**0.38**	< 0.0001	**0.002**	**0.011**
	28-Sep-23	< 0.05	**0.001**	**0.1**	< 0.0002	< 0.001	**0.004**	**0.08**	< 0.001	**0.099**	< 0.0001	**0.001**	**0.021**
	25-Oct-23	< 0.05	< 0.001	**0.73**	< 0.0002	< 0.001	< 0.001	**0.07**	< 0.001	**0.31**	< 0.0001	< 0.001	< 0.005
	27-Oct-23	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	**0.002**	**0.21**	< 0.001	**0.044**	< 0.0001	< 0.001	**0.016**
	06-Nov-23	< 0.05	**0.002**	**0.05**	< 0.0002	< 0.001	**0.006**	< 0.05	< 0.001	**0.16**	< 0.0001	< 0.001	**0.027**
	16-Nov-23	< 0.05	**0.001**	**1.2**	< 0.0002	< 0.001	**0.002**	**0.21**	< 0.001	**0.88**	< 0.0001	**0.002**	**0.006**
	18-Dec-23	< 0.05	**0.002**	**2.9**	**0.0003**	**0.002**	**0.004**	**0.12**	**0.002**	**0.56**	< 0.0001	**0.002**	**0.008**
	17-Jan-24	< 0.05	**0.002**	**2.1**	< 0.0002	< 0.001	< 0.001	**0.11**	< 0.001	**0.45**	< 0.0001	< 0.001	< 0.005

Notes:
- - Not analysed
< - Less than laboratory limit of reporting
LOR - Laboratory limit of reporting
mg/L - Milligrams per litre
Bold indicates a detection above the laboratory limit of reporting
Highlighting indicates an exceedance of the corresponding criteria (highlighting corresponds to the guideline with the highest criteria value where analytical result exceeds more than one guideline)

Criteria:
Newcastle Inner City Bypass - Rankin Park to Jesmond - Surface and Ground Water Quality Construction Monitoring Program June 2022 (Table 12)

Table 5
Field Parameters

Parameter		DO	ORP	PH	EC	TDS	TEMP	TURB
Unit		mg/L	mV	pH units	uS/cm	mg/L	deg C	NTU
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
NICB GW Maximum (Pre-Construction)		--	--	7.73	132282	--	--	19365.5
NICB GW Minimum (Pre-Construction)		--	--	3.95	653	--	--	-1.6
Location	Date							
BH307	27-Feb-23	9	248	4.34	2862	2110	18.8	2417.4
BH310	27-Feb-23	0.2	57.4	5.75	1331	962	19.7	243
BH321	03-Apr-23	8.09	49.2	5.98	1450	956	23.9	3.2
BHMW303	24-Feb-23	4.1	119.1	5.68	3499	2433	21.5	783.3
	18-May-23	4.48	150.2	5.32	3462	2530	19.2	345.31
BHMW305	27-Feb-23	0	75.4	6.02	1533	1114	19.5	44
BHMW308	01-Mar-23	7.3	108.5	6.88	738	508	22.1	1427
	18-May-23	8.68	-16.3	6.9	82.2	595	19.7	598.51
	24-Aug-23	4.1	1.9	6.77	1036	673	19.9	797
	17-Nov-23	7.68	16.9	7.25	730	542	18.5	793
BHMW309	18-May-23	5.17	-10.5	6.46	1287	939	19.3	3229.7
	24-Aug-23	3.3	-8.2	6.87	1584	1029	20.1	1782
	17-Nov-23	2.35	49	6.7	929	677	19.3	1592
BHMW312	27-Feb-23	0	33	6.95	6328	4618	19.2	19.1
	18-May-23	-0.07	-150.3	6.6	6166	4602	18.3	264.87
	24-Aug-23	-0.3	-92.9	7.47	7588	4933	18.4	40.2
	17-Nov-23	0.28	3.7	7.56	5792	4342	18	18
BHMW313	23-Feb-23	0.9	-76.9	7.22	7593	4932	20.3	200
BHMW314	23-Feb-23	0.1	1.1	6.44	12372	8042	20.7	284
	24-Aug-23	-0.8	39.1	7.1	13145	8546	18.1	24
	16-Nov-23	0.36	-12	7.08	10479	7350	21.1	33
BHMW315	23-Feb-23	0.2	42.8	6.08	653	425	22.2	143
	17-May-23	1.84	-71.9	6.03	636	442	21.6	5.55
	25-Aug-23	1.4	12.2	6.47	711	462	21.1	24
	16-Nov-23	0.17	-52.3	6.75	610	427	21.3	29
BHMW316	23-Feb-23	0.1	-24.2	6.11	3528	2295	19.2	49
	18-May-23	1.64	113.8	6.34	3517	2606	18.6	5.8
	24-Aug-23	-0.7	-114.8	6.88	4290	2789	18.7	4
	17-Nov-23	2.7	76	6.84	2745	2044	18.3	48
BHMW317	18-May-23	2.8	-129.4	6.83	1183	918	16.5	36.7
	25-Aug-23	0.9	-47.2	7.16	1617	1051	18.1	23.4
	17-Nov-23	0.41	-119.5	7.11	1211	901	18.4	6
BHMW318	29-Mar-23	6.62	130.4	6.3	1393	1012	19.5	6301.43
	17-May-23	3.32	34	6.3	1363	1014	18.4	353.5
	25-Aug-23	10.2	80.2	7	1967	1280	18.7	436
	17-Nov-23	1.39	7.1	6.81	1129	832	18.8	357
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 1-1-US Historical range		--	--	6.6 – 7.94	119 - 470	--	--	5.5 – 87.2
Location	Date							
	23-Feb-23	6.5	-22.8	7.24	337.2	220	20.9	151
	28-Mar-23	7.52	118.1	7.3	275.8	195	20.9	86.67
	21-Apr-23	1.5	-2.7	6.73	338.8	220	17.7	33.2
	19-May-23	8.52	-1.3	7.38	265.7	219	14	80.71
	30-Jun-23	3.8	28.7	6.89	456.5	297	10	37.06
	26-Jul-23	7.54	-62.7	7.53	241.5	207	12.4	41.7

Table 5
Field Parameters

	Parameter	DO	ORP	PH	EC	TDS	TEMP	TURB
	Unit	mg/L	mV	pH units	uS/cm	mg/L	deg C	NTU
WC 1-1-US	08-Aug-23	8.1	-48.9	6.95	292	190	14.5	30.9
	24-Aug-23	7.7	76	6.74	290.9	189	14	17.5
	28-Sep-23	7.23	33.5	7.13	161.8	--	17.9	106
	25-Oct-23	4.16	-89.6	8.87	392.4	222	17.6	36
	27-Oct-23	7.6	260	6.6	220	160	--	76.9
	06-Nov-23	7.46	--	7.6	281.8	214	17.6	99
	16-Nov-23	3.23	-49.9	7.51	337.4	257	20	8.7
	18-Dec-23	287	-46.3	7.03	625	429	22.2	3
	17-Jan-24	3.01	11.5	6.87	298.5	205	22.2	0.84
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 1-3-DS Historical range		--	--	6.91 – 8.79	166 – 1290	--	--	1.2 - 41.5
Location	Date							
WC 1-3-DS	23-Feb-23	9.1	97.4	7.45	219.2	142	21.7	453
	28-Mar-23	8.95	115.2	7.24	308	214	21.7	1473.17
	21-Apr-23	10	114.6	7.85	325.9	212	18.9	192.6
	19-May-23	10.14	56.9	7.85	352.1	281	15.3	39.27
	30-Jun-23	10.6	103.2	8.36	468.1	304	12.6	-2.5
	26-Jul-23	10.32	90.5	7.73	358.9	277	16.7	9
	08-Aug-23	9.9	42.6	7.82	404.9	263	17.4	321
	24-Aug-23	9.6	49.2	8.76	549	357	14.7	9.7
	28-Sep-23	9.2	87.5	7.95	225.8	153	23	28
	25-Oct-23	10.75	36.1	9.92	299.1	222	18.5	10
	27-Oct-23	8.6	260	6.6	250	160	--	52.9
	06-Nov-23	9.04	--	7.7	385.4	276	20.2	110
	16-Nov-23	11.14	-23.7	9.91	527	360	22.5	7.6
	18-Dec-23	9.96	65.2	8.93	899	598	23.9	8.7
	17-Jan-24	8.31	84.3	8.45	1187	790	23.1	5.7
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 2-2-DS Historical range		--	--	No Sample	No Sample	--	--	No Sample
Location	Date							
WC 2-2-DS	06-Nov-23	4.18	--	5.9	137.7	105	17.1	1950
	16-Nov-23	0.96	-7.2	6.7	190	133	21.5	962
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 3-2-DS Historical range		--	--	6.16 – 7.77	66 – 974	--	--	77.5 - 268.1
Location	Date							
WC 3-2-DS	24-Feb-23	6.9	155.5	6.07	232.8	151	20.1	383
	28-Mar-23	7.52	166.1	5.75	191.9	135	20.9	1005.6
	21-Apr-23	8.48	165.4	5.9	306.3	199	17.5	712
	19-May-23	9.01	95.3	6.64	203.1	171	13	656.5
	24-Aug-23	10.1	101.3	7.58	974	633	16.7	16
	27-Oct-23	5.8	280	6	260	760	--	>1000
	06-Nov-23	7.92	--	5.2	438.2	326	18.4	484
	16-Nov-23	7.73	208	5.29	656	440	23.4	217
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 4-1-US Historical range		--	--	6.11 – 8.30	129 – 283	--	--	1 - 50.9
Location	Date							
	24-Feb-23	5.7	32.5	6.65	220.7	160	19.5	6.15
	28-Mar-23	5.32	41.7	6.39	173.5	124	20.1	50.85
	21-Apr-23	7.43	90.9	6.82	175.9	114	17.5	20.44

Table 5
Field Parameters

	Parameter	DO	ORP	PH	EC	TDS	TEMP	TURB
	Unit	mg/L	mV	pH units	uS/cm	mg/L	deg C	NTU
WC 4-1-US	19-May-23	8.21	61.7	6.76	--	127	13.4	14.79
	30-Jun-23	9.9	194.5	6.85	239.8	156	10	-12.88
	26-Jul-23	10.52	45.8	6.71	143.2	126	11.3	5.2
	08-Aug-23	10	90.6	6.73	197	128	13.9	5.37
	25-Aug-23	9.3	26.8	8.16	207.1	135	12.5	0
	28-Sep-23	0.54	27.1	6.29	192	152	15.7	7
	25-Oct-23	1.32	-52.4	8.52	222	171	16.9	4
	27-Oct-23	8.6	250	6	250	340	--	900
	06-Nov-23	5.02	--	7.1	169	131	16.4	48.9
	16-Nov-23	0.82	-62.2	6.71	186.6	142	17.4	2
	18-Dec-23	0.49	-59.8	6.48	297.5	214	20	10.5
	17-Jan-24	0.57	-3.3	6.27	244.8	174	20.5	4.6
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 4-2-DS Historical range		--	--	6.38 – 8.07	150 – 382.6	--	--	5.6 – 81.6
Location	Date							
WC 4-2-DS	24-Feb-23	7	106.3	6.7	294.2	214	19.5	13.96
	28-Mar-23	7.52	91.9	6.71	246.4	175	20.5	38
	21-Apr-23	8.41	83.1	6.84	260.1	169	17.4	32.01
	19-May-23	9.1	78.6	6.86	225.9	189	13.4	46.13
	30-Jun-23	9.9	155.4	6.67	382.6	249	10	6.66
	26-Jul-23	11.25	85	6.78	207.4	183	11.2	38
	08-Aug-23	10	95.8	6.65	311.9	203	13.7	56.43
	25-Aug-23	10	68	7.39	235	9153	12.1	16
	28-Sep-23	6.58	133.1	6.75	133.1	243	17	241
	25-Oct-23	6.97	1.8	8.98	235.4	179	17.4	3.54
	27-Oct-23	8.5	260	6.1	330	290	--	345
	06-Nov-23	8.46	--	6.9	273.5	209	17.3	114
	16-Nov-23	7.76	12.1	7.34	316.5	229	19.6	6
	18-Dec-23	6.91	7.4	6.91	571	394	21.9	10.3
	17-Jan-24	7.62	53.8	6.46	542	359	24.1	17.9
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 4-3-US Historical range		--	--	6.52 – 7.96	176 – 936	--	--	4.4 – 58.6
Location	Date							
WC 4-3-US	24-Feb-23	6.8	85.3	6.94	471.5	342	19.5	10.83
	28-Mar-23	7.18	102.2	6.85	363.3	261	20	24.8
	21-Apr-23	8.09	82.2	7	407.6	266	17.4	20.18
	19-May-23	6.93	92.8	6.73	371.7	307	13.8	10.61
	26-Jul-23	1.41	62.1	5.73	845	657	16.4	17
	08-Aug-23	2.7	99.8	6.25	741	482	13.8	2.3
	25-Aug-23	2.4	88.7	7.23	585	380	12.9	2.88
	27-Oct-23	6.2	240	6	350	220	--	68.8
	06-Nov-23	1.81	--	6.7	313	237	17.6	41.6
	16-Nov-23	3.34	43.9	7.11	368.7	268	19.4	16
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC 5-1-DS Historical range		--	--	5.94 – 6.06	232 – 769	--	--	10.28 – 62.3
Location	Date							
	24-Feb-23	3.1	160.4	5.95	677	440	20.1	10.28
	28-Mar-23	5.13	110.9	6.22	577	413	20.2	96.73
	21-Apr-23	6.3	102.6	6.49	563	366	17.7	20.8

Table 5
Field Parameters

	Parameter	DO	ORP	PH	EC	TDS	TEMP	TURB
	Unit	mg/L	mV	pH units	uS/cm	mg/L	deg C	NTU
WC 5-1-DS	19-May-23	5.9	112	6.26	475.9	381	15.2	18.58
	30-Jun-23	5.6	133.8	6.23	620	403	11.3	-6.48
	26-Jul-23	6.66	80.7	6.15	483	410	12.7	4
	08-Aug-23	5.8	140	5.73	698	454	14.3	6.15
	24-Aug-23	5	134.4	6.27	769	500	14.2	24
	06-Nov-23	5.98	--	6.6	525	402	17.1	59
	16-Nov-23	4.19	78	6.69	627	462	18.8	8
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC Blue Wren Ck-DS Historical range		--	--	6.50 – 7.57	170 – 818	--	--	3.5 – 72
Location	Date							
WC Blue Wren Ck-DS	24-Feb-23	4.3	7.7	6.66	455.1	296	22.4	10.73
	28-Mar-23	7.81	73.3	6.89	405.4	285	21.1	22.6
	21-Apr-23	8.31	64.3	7.11	362.5	236	18.2	41.17
	19-May-23	7.47	36.1	6.82	306.1	251	14.2	16.3
	30-Jun-23	1.2	12.7	6.44	818	501	11.3	14.8
	26-Jul-23	2.23	-18	6.56	362.4	320	11.4	1.89
	08-Aug-23	6.7	-10.1	6.63	438	285	14.1	24.2
	24-Aug-23	1	-43.9	7.98	331.9	216	14	0.2
	28-Sep-23	4.68	15.9	6.71	206.5	151	18.8	21
	25-Oct-23	0.94	-93.3	8.74	349.7	265	17.6	5.4
	27-Oct-23	6.2	240	5.9	170	98	--	83.4
	06-Nov-23	8.24	--	7.4	387.7	292	17.9	97
	16-Nov-23	1.06	-90	7.38	308	221	20.5	1
	18-Dec-23	1.49	-101.2	6.93	559	372	23.8	0.8
	17-Jan-24	1.25	-39.9	6.81	273	184	23.1	3.9
NICB - Default Water Quality Performance Criteria		85 - 110		6.0 - 8.0	2200			6 - 50
WC Ironbark Ck-DS Historical range		--	--	6.63 – 7.74	240 - 28484	--	--	9.6 – 79.4
Location	Date							
WC Ironbark Ck-DS	24-Feb-23	1.6	84	6.5	1956	1260	19	19.8
	28-Mar-23	6.85	108.9	6.85	531	376	20.7	59.97
	21-Apr-23	5.35	121.7	6.85	585	381	18.5	132.45
	19-May-23	6.07	46.7	6.94	5660	4585	14.7	33.5
	30-Jun-23	8.5	134.5	7.44	28484	18546	10.3	-4.8
	26-Jul-23	7.06	45.7	6.96	4681	3972	12.7	36
	08-Aug-23	5.8	-51.2	7.52	3296	2146	18	7.89
	24-Aug-23	3.2	50.1	7.51	24253	15765	15.9	7
	28-Sep-23	7.74	66.7	7.23	629	457	19.3	30
	25-Oct-23	1.88	77.3	7.77	30022	21314	20.7	10.4
	27-Oct-23	8	260	7.2	400	230	--	21
	06-Nov-23	4.05	--	7.3	381.5	283	18.4	139
	16-Nov-23	0.91	8.5	7.41	15692	10416	23.9	9
	18-Dec-23	1.14	99.5	7.09	52064	33602	25.4	5
	17-Jan-24	1.39	152.1	7.02	30000	20000	23.8	16.95

Table 6
Gauging data

Location	Date	DTW (mBTOC)	Total Well Depth (m)	TOC (mAHD)	Water Table Elevation (mAHD)	Dry Indicator (Y/N)	Remark	Technician
BH307	27-Feb-23	12.323	110.760	99.720	11.040	N	Brown	A King
	03-Apr-23	12.331	NM	NM	10.849	N	--	A King
	26-Apr-23	NM	NM	NM	NC	--	Decommissioned	AK, KB
BH310	27-Feb-23	18.317	125.090	110.882	14.208	N	Odor, Light brown	A King
BH315	24-Feb-23	21.170	114.960	94.096	20.864	N	--	D Kousbroek
	03-Apr-23	21.113	NM	NM	20.858	N	--	A King
	26-Apr-23	NM	NM	NM	NC	--	Decommissioned	AK, KB
BH321	03-Apr-23	26.388	NM	NM	25.494	N	Cloudy brown	A King
	26-Apr-23	NM	NM	NM	NC	--	Decommissioned	AK, KB
BH326	01-Mar-23	14.184	85.130	71.008	14.122	N	--	A King
	03-Apr-23	14.360	NM	NM	14.150	N	--	A King
	26-Apr-23	NM	NM	NM	NC	--	Decommissioned	AK, KB
BHMW302	27-Feb-23	15.205	101.870	NM	NC	Y	Dry, Light brown	A King
BHMW303	24-Feb-23	8.380	115.110	107.295	7.815	N	Weak Odor, Cloudy brown/grey	D Kousbroek
	28-Mar-23	8.272	NM	NM	7.835	N	--	A King
	26-Apr-23	8.275	NM	NM	7.867	N	Standpipe in good condition	AK, KB
	18-May-23	8.285	NM	NM	7.874	N	Light brown	A King
	25-Aug-23	8.265	115.110	107.020	8.090	N	Insufficient water, slow recharge, logger possibly faulty	AK, MM
	17-Nov-23	8.273	NM	NM	NC	Y	Dry	A King
BHMW304	27-Feb-23	15.740	86.400	NM	NC	Y	Dry	A King
	28-Mar-23	15.801	NM	NM	15.579	N	--	A King
	26-Apr-23	15.780	NM	NM	15.664	N	Standpipe, possible root inundation	AK, KB
	17-May-23	15.810	NM	NM	15.733	N	--	A King
	25-Aug-23	15.783	86.400	70.733	15.667	N	Insufficient water, slow recharge	AK, MM
	17-Nov-23	15.800	NM	NM	NC	Y	Dry	A King
BHMW305	27-Feb-23	15.872	55.760	46.920	8.840	N	Clear	A King
	28-Mar-23	15.885	NM	NM	8.938	N	--	A King
	26-Apr-23	15.883	NM	NM	9.044	N	Standpipe in good condition	AK, KB
	17-May-23	NM	NM	NM	NC	--	--	A King
BHMW308	01-Mar-23	30.000	84.450	54.450	30.000	N	Brown	A King
	28-Mar-23	30.000	NM	NM	0.000	N	--	A King
	26-Apr-23	35.610	NM	NM	34.493	N	Gatic cover, good condition	AK, KB
	18-May-23	35.594	NM	NM	34.425	N	--	A King
	24-Aug-23	35.550	84.450	49.547	34.903	N	Light brown, earthy odour, no sheen, slow recharge, bailed	AK, MM
	17-Nov-23	35.600	NM	NM	34.805	N	Brown	A King
BHMW309	23-Feb-23	15.620	39.900	27.429	12.471	N	--	D Kousbroek
	28-Mar-23	15.430	NM	NM	13.657	N	--	A King
	26-Apr-23	15.470	NM	NM	14.224	N	Gatic cover in good condition	AK, KB
	18-May-23	15.534	NM	NM	14.463	N	Brown	A King
	24-Aug-23	15.165	39.900	25.281	14.619	N	Brown, high sediment, no odour, no sheen, slow recharge, bailed	AK, MM
	17-Nov-23	15.420	NM	NM	13.782	N	Greyish brown	A King
BHMW310	27-Feb-23	14.737	32.870	NM	NC	Y	Dry	A King
	03-Apr-23	14.750	NM	NM	NC	Y	Dry	A King
	26-Apr-23	14.740	NM	NM	NC	Y	Gatic in good condition, DRY	AK, KB
	17-May-23	14.770	NM	NM	NC	Y	Dry	A King
	24-Aug-23	14.740	32.870	NM	NC	Y	Dry	AK, MM
	16-Nov-23	14.778	NM	NM	NC	Y	Dry	A King
BHMW311	26-Apr-23	20.770	NM	NM	6.167	N	Standpipe in good condition	AK, KB
	18-May-23	5.787	NM	NM	NC	Y	Dry	A King
	24-Aug-23	5.835	20.980	NM	NC	Y	Dry	AK, MM
	16-Nov-23	5.857	NM	NM	NC	Y	Dry	A King
BHMW312	27-Feb-23	20.750	13.830	7.801	6.029	N	Clear	A King
	28-Mar-23	20.765	NM	NM	6.122	N	--	A King
	26-Apr-23	5.782	NM	NM	NC	Y	Standpipe appears to be full of sand, DRY	AK, KB
	18-May-23	20.770	NM	NM	6.312	N	Odor, Cloudy white	A King
	24-Aug-23	20.750	13.830	6.603	7.227	N	White, low Sulphur odour, no sheen	AK, MM
	17-Nov-23	20.792	NM	NM	7.211	N	Clear	A King
BHMW313	23-Feb-23	15.130	9.000	8.379	0.621	N	--	D Kousbroek
	26-Apr-23	NM	NM	NM	NC	--	Unable to locate beneath mulch / lost	AK, KB
	17-May-23	NM	NM	NM	NC	--	--	A King
	23-Feb-23	15.070	7.400	6.656	0.744	N	Light brown	D Kousbroek

Table 6
Gauging data

Location	Date	DTW (mBTOC)	Total Well Depth (m)	TOC (mAHD)	Water Table Elevation (mAHD)	Dry Indicator (Y/N)	Remark	Technician
BHMW314	28-Mar-23	14.900	NM	NM	0.600	N	--	A King
	26-Apr-23	14.892	NM	NM	0.581	N	Gatic cover rusted	AK, KB
	24-Aug-23	14.860	7.400	6.824	0.576	N	Decommissioned	AK, MM
	16-Nov-23	14.900	NM	NM	0.601	N	Clear	A King
BHMW315	23-Feb-23	15.100	15.300	12.429	2.871	N	Light yellow/brown	D Kousbroek
	28-Mar-23	14.920	NM	NM	3.105	N	--	A King
	26-Apr-23	14.874	NM	NM	2.920	N	Gatic in good condition	AK, KB
	17-May-23	14.888	NM	NM	2.962	N	--	A King
	25-Aug-23	14.870	15.300	12.110	3.190	N	Clear, no odour, no sheen	AK, MM
	16-Nov-23	14.914	NM	NM	3.017	N	Clear	A King
BHMW316	23-Feb-23	0.000	25.880	13.048	12.832	N	Odor, Clear	D Kousbroek
	28-Mar-23	0.000	NM	NM	12.858	N	--	A King
	26-Apr-23	39.940	NM	NM	12.976	N	Standpipe lid broken	AK, KB
	18-May-23	40.300	NM	NM	12.934	N	Mild opaque	A King
	24-Aug-23	39.705	25.880	12.835	13.045	N	Clear, low Sulphur odour, no sheen	AK, MM
	17-Nov-23	39.850	NM	NM	13.035	N	Odor, Clear	A King
BHMW317	28-Mar-23	NM	NM	NM	26.028	N	--	A King
	26-Apr-23	33.615	NM	NM	25.679	N	Standpipe in good condition	AK, KB
	18-May-23	33.750	NM	NM	25.859	N	Odor	A King
	25-Aug-23	33.750	47.810	21.876	25.934	N	Clear, moderate Sulphur odour, no sheen	AK, MM
	17-Nov-23	33.688	NM	NM	25.880	N	Odor, Clear	A King
BHMW318	29-Mar-23	25.435	NM	NM	14.222	N	Odor, Brown/orange	A King
	26-Apr-23	25.310	NM	NM	13.822	N	Sediment in well water, standpipe in good condition	AK, KB
	17-May-23	25.175	NM	NM	13.903	N	--	A King
	25-Aug-23	25.190	76.080	61.560	14.520	N	Clear, moderate Sulphur odour, no sheen	AK, MM
	17-Nov-23	25.010	NM	NM	13.985	N	Orange	A King
WC1-1-US	23-Feb-23	NM	NM	NM	NC	--	Cloudy light grey	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Very light yellow, NO/NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Slight cloudy brown, no odour, no sheen.	DK, MM
	24-Aug-23	0.200	NM	NM	NC	N	Orange, no odour, no sheen	AK, MM
	28-Sep-23	0.400	NM	NM	0.200	N	--	AK DK
	06-Nov-23	0.200	NM	NM	0.100	N	Light brown, earthy odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Clear	A King
WC 1-3-DS	23-Feb-23	NM	NM	NM	NC	--	Light brown,turbid	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Turbid light brown, NO/NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Slight cloudy brown, no odour, no sheen	DK, MM
	24-Aug-23	0.100	NM	NM	NC	N	Clear, no odour, no sheen	AK, MM
	28-Sep-23	0.100	NM	NM	0.100	N	--	AK DK
	25-Oct-23	NM	NM	NM	NC	N	Clear, no sheen, no odour	AK, TJ
	27-Oct-23	NM	NM	NM	NC	N	Clear, no sheen, no odour	TJ
	06-Nov-23	0.200	NM	NM	0.100	N	Light brown, grassy odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Clear	A King
WC2-2-DS	24-Feb-23	NM	NM	NM	NC	--	--	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	Y	Dry	MF, KB
	30-Jun-23	NM	NM	NM	NC	Y	--	Aaron King
	08-Aug-23	NM	NM	NM	NC	Y	Dry	DK, MM
	24-Aug-23	NM	NM	NM	NC	Y	Dry	AK, MM
	28-Sep-23	NM	NM	NM	NC	Y	--	AK DK
	06-Nov-23	0.200	NM	NM	0.100	N	Brown, very high turbidity, earthy odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Odor, Brown	A King
WC 3-2-DS	24-Feb-23	NM	NM	NM	NC	--	Light brown	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Cloudy grey/brown, very turbid, NO/NS	MF, KB
	30-Jun-23	NM	NM	NM	NC	Y	--	Aaron King
	08-Aug-23	NM	NM	NM	NC	Y	Dry	DK, MM
	24-Aug-23	0.200	NM	NM	NC	N	Clear, no odour, no sheen	AK, MM
	28-Sep-23	NM	NM	NM	NC	Y	--	AK DK
	25-Oct-23	NM	NM	NM	NC	Y	Dry	AK, TJ
	27-Oct-23	NM	NM	NM	NC	N	Brown, no sheen, no odour, highly turbid, metals not filtered	TJ
	06-Nov-23	0.200	NM	NM	0.100	N	Brown, no odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Greenish brown	A King
	24-Feb-23	NM	NM	NM	NC	--	Clear	D Kousbroek

Table 6
Gauging data

Location	Date	DTW (mBTOC)	Total Well Depth (m)	TOC (mAHD)	Water Table Elevation (mAHD)	Dry Indicator (Y/N)	Remark	Technician
WC4-1-US	21-Apr-23	NM	NM	NM	NC	N	Clear, NO/NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Clear, no odour, no sheen.	DK, MM
	25-Aug-23	0.300	NM	NM	NC	N	Light blue and cloudy, no odour, no sheen	AK, MM
	28-Sep-23	0.400	NM	NM	0.200	N	--	AK DK
	06-Nov-23	0.600	NM	NM	0.300	N	Clear to greyish brown, no odour, no sheen, water bugs	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Odor, Clear	A King
WC 4-2-DS	24-Feb-23	NM	NM	NM	NC	--	Clear	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Clear/slightly cloudy, NO/NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Slightly cloudy, no odour, no sheen	DK, MM
	25-Aug-23	0.200	NM	NM	NC	N	Clear, no odour, minor biofilm	AK, MM
	28-Sep-23	0.200	NM	NM	0.100	N	--	AK DK
	25-Oct-23	NM	NM	NM	NC	N	Clear, no sheen, no odour, minor bio film	AK, TJ
	27-Oct-23	NM	NM	NM	NC	N	Brown, no sheen, no odour, metals not filtered	TJ
	06-Nov-23	0.400	NM	NM	0.200	N	Light brown, no odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Clear	A King
WC 4-3-US	24-Feb-23	NM	NM	NM	NC	--	Clear	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Clear, slight sulphur odour, NS	MF, KB
	30-Jun-23	NM	NM	NM	NC	Y	Not flowing	Aaron King
	08-Aug-23	NM	NM	NM	NC	N	Clear, no odour, no sheen	DK, MM
	25-Aug-23	0.100	NM	NM	NC	N	Clear to brown tanins, no odour, no sheen	AK, MM
	28-Sep-23	NM	NM	NM	NC	Y	--	AK DK
	25-Oct-23	NM	NM	NM	NC	Y	Dry	AK, TJ
	27-Oct-23	NM	NM	NM	NC	N	Brown, no sheen, no odour	TJ
	06-Nov-23	0.300	NM	NM	0.100	N	Light brown, earthy odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Clear	A King
WC 5-1-DS	24-Feb-23	NM	NM	NM	NC	--	Clear	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Clear, NO/NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Clear, no odour, no sheen	DK, MM
	24-Aug-23	0.200	NM	NM	NC	N	Clear, no odour, minor biofilm, mosquito larvae present	AK, MM
	28-Sep-23	NM	NM	NM	NC	Y	--	AK DK
	25-Oct-23	NM	NM	NM	NC	Y	Dry	AK, TJ
	27-Oct-23	NM	NM	NM	NC	Y	Dry	TJ
	06-Nov-23	0.200	NM	NM	0.100	N	Light brown, no odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Clear	A King
WC BLUE WREN CK-DS	24-Feb-23	NM	NM	NM	NC	--	Clear	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Cloudy brown, NO/NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Slight cloudy brown, water running, no odour, no sheen	DK, MM
	24-Aug-23	0.300	NM	NM	NC	N	Clear, no odour, no sheen	AK, MM
	28-Sep-23	0.400	NM	NM	0.200	N	--	AK DK
	25-Oct-23	NM	NM	NM	NC	N	Biofilm, clear, no sheen, no odour	AK, TJ
	27-Oct-23	NM	NM	NM	NC	N	Light brown, no sheen, no odour	TJ
	06-Nov-23	0.500	NM	NM	0.200	N	Brown, no odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Clear	A King
WC IRONBARK CK-DS	24-Feb-23	NM	NM	NM	NC	--	Light brown tannin	D Kousbroek
	21-Apr-23	NM	NM	NM	NC	N	Brown, turbid, fishy odour, NS	MF, KB
	08-Aug-23	NM	NM	NM	NC	N	Clear, some brown tannins, no odour, no sheen.	DK, MM
	24-Aug-23	1.500	NM	NM	NC	N	Clear, no odour, no sheen, orange algae	AK, MM
	28-Sep-23	1.000	NM	NM	0.500	N	--	AK DK
	25-Oct-23	NM	NM	NM	NC	N	Clear , no sheen, no odour	AK, TJ
	27-Oct-23	NM	NM	NM	NC	N	Light brown to clear, no sheen, no odour	TJ
	06-Nov-23	2.000	NM	NM	0.500	N	Brown, earthy odour, no sheen	AK TJ
	16-Nov-23	NM	NM	NM	NC	--	Brown tanin	A King

Table Q1
QAQC - Inorganics and Nutrients RPD values

Analyte			Anions and Cations					Anions and Cations				Inorganics			
			Total Phosphorus	Nitrite as N	Nitrate	Nitrite + Nitrate as N	Total Ammonia as Nitrogen	Total Kjeldahl Nitrogen as N	Nitrogen	Redox potential	Electrical Conductivity @ 25°C	Total Dissolved Solids	Total suspended solids	pH in Lab	Phosphate Total (as P)
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mV	µS/cm	mg/L	mg/L	pH units	mg/L
Sample Name	Sample Date	Sample Type													
WC IRONBARK CK-DS_21042023	21-Apr-23	Primary	**0.11**	-	-	**0.33**	-	**0.9**	**1.2**	-	-	-	**46**	-	-
QC01_21042023	21-Apr-23	Duplicate	**0.12**	-	-	**0.34**	-	**0.9**	**1.2**	-	-	-	**47**	-	-
Relative Percentage Difference			**9%**	NC	NC	**3%**	NC	**0%**	**0%**	NC	NC	NC	**2%**	NC	NC
WC IRONBARK CK-DS_21042023	21-Apr-23	Primary	**0.11**	-	-	**0.33**	-	**0.9**	**1.2**	-	-	-	**46**	-	-
QC01A_21042023	21-Apr-23	Triplicate	-	< 0.02	**0.31**	**0.31**	**0.05**	**1.1**	**1.41**	-	-	-	**24**	-	**0.05**
Relative Percentage Difference			NC	NC	NC	**6%**	NC	**20%**	**16%**	NC	NC	NC	**63%**	NC	NC
WC BLUE WREN CK DS_30062023	30-Jun-23	Primary	-	< 0.02	< 0.02	< 0.05	-	< 0.2	< 0.1	-	-	-	**23**	-	**0.06**
QC01_30062023	30-Jun-23	Duplicate	-	< 0.02	< 0.02	< 0.05	-	< 0.2	< 0.1	-	-	-	< 5.0	-	**0.05**
Relative Percentage Difference			NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	**129%**	NC	**18%**
WC BLUE WREN CK DS_30062023	30-Jun-23	Primary	-	< 0.02	< 0.02	< 0.05	-	< 0.2	< 0.1	-	-	-	**23**	-	**0.06**
QC02_30062023	30-Jun-23	Triplicate	**0.08**	-	-	**0.15**	-	**0.6**	**0.8**	-	-	-	**28**	-	-
Relative Percentage Difference			NC	NC	NC	**100%**	NC	**100%**	**156%**	NC	NC	NC	**20%**	NC	NC
WC IRONBARK CK-DS_26072023	26-Jul-23	Primary	-	< 0.02	**0.26**	**0.26**	-	**0.6**	**0.86**	-	-	-	**12**	-	**0.08**
QC01_26072023	26-Jul-23	Duplicate	-	< 0.02	**0.26**	**0.26**	-	< 0.2	**0.26**	-	-	-	**16**	-	**0.07**
Relative Percentage Difference			NC	NC	**0%**	**0%**	NC	**100%**	**107%**	NC	NC	NC	**29%**	NC	**13%**
WC IRONBARK CK-DS_26072023	26-Jul-23	Primary	-	< 0.02	**0.26**	**0.26**	-	**0.6**	**0.86**	-	-	-	**12**	-	**0.08**
QC01A_26072023	26-Jul-23	Triplicate	**0.1**	-	-	**0.26**	-	**0.6**	**0.9**	-	-	-	**28**	-	-
Relative Percentage Difference			NC	NC	NC	**0%**	NC	**0%**	**5%**	NC	NC	NC	**80%**	NC	NC
BHMW317_17112023	17-Nov-23	Primary	-	< 0.02	< 0.02	< 0.05	-	**0.4**	**0.4**	-	-	-	**10**	-	**0.01**
QC01_17112023	17-Nov-23	Duplicate	-	< 0.02	< 0.02	< 0.05	-	**0.3**	**0.3**	-	-	-	**9.2**	-	< 0.01
Relative Percentage Difference			NC	NC	NC	NC	NC	**29%**	**29%**	NC	NC	NC	**8%**	NC	**0%**
BHMW317_17112023	17-Nov-23	Primary	-	< 0.02	< 0.02	< 0.05	-	**0.4**	**0.4**	-	-	-	**10**	-	**0.01**
QC01A_16112023	17-Nov-23	Triplicate	< 0.01	-	-	< 0.01	-	**0.3**	**0.3**	-	-	-	**13**	-	-
Relative Percentage Difference			NC	NC	NC	NC	NC	**29%**	**29%**	NC	NC	NC	**26%**	NC	NC
WC BLUE WREN CK-DS_18122023	18-Dec-23	Primary	NA	< 0.02	**0.02**	< 0.05	-	< 0.2	< 0.2	-	-	-	**5.1**	-	**0.06**
QC01_18122023	18-Dec-23	Duplicate	NA	< 0.02	< 0.02	< 0.05	-	**0.9**	**0.9**	-	-	-	**7.7**	-	**0.02**
Relative Percentage Difference			NC	NC	**0%**	NC	NC	**127%**	**127%**	NC	NC	NC	**41%**	NC	**100%**
WC BLUE WREN CK-DS_18122023	18-Dec-23	Primary	NA	< 0.02	**0.02**	< 0.05	-	< 0.2	< 0.2	-	-	-	**5.1**	-	**0.06**
QC01A_18122023	18-Dec-23	Triplicate	**0.21**	NA	NA	**0.03**	-	**0.7**	**0.7**	-	-	-	**12**	-	NA
Relative Percentage Difference			NC	NC	NC	**50%**	NC	**111%**	**111%**	NC	NC	NC	**81%**	NC	NC
WC IRONBARK CK-DS_17012024	17-Jan-24	Primary	-	< 0.02	< 0.02	< 0.05	-	**1.3**	**1.3**	-	-	-	**40**	-	**0.06**
QC01_17012024	17-Jan-24	Duplicate	-	< 0.02	**0.03**	< 0.05	-	**1.6**	**1.6**	-	-	-	**30**	-	**0.08**
Relative Percentage Difference			NC	NC	**40%**	NC	NC	**21%**	**21%**	NC	NC	NC	**29%**	NC	**29%**
WC IRONBARK CK-DS_17012024	17-Jan-24	Primary	-	< 0.02	< 0.02	< 0.05	-	**1.3**	**1.3**	-	-	-	**40**	-	**0.06**
QC01A_17012024	17-Jan-24	Triplicate	**0.21**	-	-	**0.01**	-	**1.2**	**1.2**	-	-	-	**25**	-	-
Relative Percentage Difference			NC	NC	NC	**133%**	NC	**8%**	**8%**	NC	NC	NC	**46%**	NC	NC

Notes:
- - Not analysed
< - Less than laboratory limit of reporting
NC - Not calculated
mg/L - Milligrams per litre
µS/cm - Microsiemens per centimeter
mV - Millivolts
RPD - Relative Percentage Difference

Table Q2
QAQC Dissolved metals RPD Values

Analyte			Metals														
			Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Tin	Zinc
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Name	Sample Date	Sample Type																
WC IRONBARK CK-DS_21042023	21-Apr-23	Primary	**0.21**	< 0.001	< 0.05	< 0.0001	< 0.001	**0.004**	**0.16**	< 0.001	**0.065**	< 0.0001	-	**0.001**	-	-	-	**0.016**
QC01_21042023	21-Apr-23	Duplicate	< 0.01	< 0.001	< 0.05	< 0.0001	< 0.001	**0.005**	**0.08**	< 0.001	**0.066**	< 0.0001	-	**0.001**	-	-	-	**0.013**
Relative Percentage Difference			**182%**	NC	NC	NC	NC	**22%**	**67%**	NC	**2%**	NC	NC	**0%**	NC	NC	NC	**21%**
WC IRONBARK CK-DS_21042023	21-Apr-23	Primary	**0.21**	< 0.001	< 0.05	< 0.0001	< 0.001	**0.004**	**0.16**	< 0.001	**0.065**	< 0.0001	-	**0.001**	-	-	-	**0.016**
QC01A_21042023	21-Apr-23	Triplicate	< 0.05	< 0.001	**0.07**	< 0.0002	< 0.001	**0.003**	**0.11**	< 0.001	**0.069**	< 0.0001	< 0.005	**0.001**	< 0.001	< 0.005	< 0.005	**0.012**
Relative Percentage Difference			**123%**	NC	**33%**	NC	NC	**29%**	**37%**	NC	**6%**	NC	NC	**0%**	NC	NC	NC	**29%**
WC BLUE WREN CK DS_30062023	30-Jun-23	Primary	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	< 0.001	**7.4**	< 0.001	**0.98**	< 0.0001	-	< 0.001	-	-	-	< 0.005
QC01_30062023	30-Jun-23	Duplicate	< 0.05	**0.001**	< 0.05	< 0.0002	< 0.001	< 0.001	**7.5**	< 0.001	**0.99**	< 0.0001	-	< 0.001	-	-	-	< 0.005
Relative Percentage Difference			NC	**67%**	NC	NC	NC	NC	**1%**	NC	**1%**	NC	NC	NC	NC	NC	NC	NC
WC BLUE WREN CK DS_30062023	30-Jun-23	Primary	< 0.05	**0.002**	< 0.05	< 0.0002	< 0.001	< 0.001	**7.4**	< 0.001	**0.98**	< 0.0001	-	< 0.001	-	-	-	< 0.005
QC02_30062023	30-Jun-23	Triplicate	< 0.01	**0.001**	< 0.05	< 0.0001	**0.002**	< 0.001	**8.58**	< 0.001	**1.04**	< 0.0001	-	< 0.001	-	-	-	< 0.005
Relative Percentage Difference			NC	**67%**	NC	NC	**67%**	NC	**15%**	NC	**6%**	NC	NC	NC	NC	NC	NC	NC
WC IRONBARK CK-DS_26072023	26-Jul-23	Primary	< 0.05	< 0.001	**0.38**	< 0.0002	< 0.001	< 0.001	**0.09**	< 0.001	**0.4**	< 0.0001	-	**0.002**	-	-	-	**0.009**
QC01_26072023	26-Jul-23	Duplicate	< 0.05	< 0.001	**0.37**	< 0.0002	< 0.001	**0.003**	**0.08**	< 0.001	**0.41**	< 0.0001	-	**0.002**	-	-	-	**0.01**
Relative Percentage Difference			NC	NC	**3%**	NC	NC	**100%**	**12%**	NC	**2%**	NC	NC	**0%**	NC	NC	NC	**11%**
WC IRONBARK CK-DS_26072023	26-Jul-23	Primary	< 0.05	< 0.001	**0.38**	< 0.0002	< 0.001	< 0.001	**0.09**	< 0.001	**0.4**	< 0.0001	-	**0.002**	-	-	-	**0.009**
QC01A_26072023	26-Jul-23	Triplicate	**0.07**	< 0.001	**0.3**	< 0.0001	< 0.001	< 0.001	**0.09**	< 0.001	**0.431**	< 0.0001	-	**0.002**	-	-	-	**0.009**
Relative Percentage Difference			**33%**	NC	**24%**	NC	NC	NC	**0%**	NC	**7%**	NC	NC	**0%**	NC	NC	NC	**0%**
BHMW317_17112023	17-Nov-23	Primary	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	< 0.001	**1.5**	< 0.001	**0.18**	< 0.0001	-	**0.009**	-	-	-	< 0.005
QC01_17112023	17-Nov-23	Duplicate	< 0.05	< 0.001	**0.07**	< 0.0002	< 0.001	< 0.001	**1.4**	< 0.001	**0.18**	< 0.0001	-	**0.01**	-	-	-	< 0.005
Relative Percentage Difference			NC	NC	**15%**	NC	NC	NC	**7%**	NC	**0%**	NC	NC	**11%**	NC	NC	NC	NC
BHMW317_17112023	17-Nov-23	Primary	< 0.05	< 0.001	**0.06**	< 0.0002	< 0.001	< 0.001	**1.5**	< 0.001	**0.18**	< 0.0001	-	**0.009**	-	-	-	< 0.005
QC01A_16112023	17-Nov-23	Triplicate	< 0.01	< 0.001	**0.06**	< 0.0001	< 0.001	< 0.001	**1.57**	< 0.001	**0.194**	< 0.0001	-	**0.009**	-	-	-	< 0.005
Relative Percentage Difference			NC	NC	**0%**	NC	NC	NC	**5%**	NC	**7%**	NC	NC	**0%**	NC	NC	NC	NC
WC BLUE WREN CK-DS_18122023	18-Dec-23	Primary	< 0.05	**0.003**	**0.06**	< 0.0002	< 0.001	< 0.001	**6.5**	< 0.001	**0.57**	< 0.0001	-	< 0.001	-	-	-	< 0.005
QC01_18122023	18-Dec-23	Duplicate	< 0.05	**0.003**	**0.06**	< 0.0002	< 0.001	< 0.001	**7.0**	< 0.001	**0.58**	< 0.0001	-	< 0.001	-	-	-	< 0.005
Relative Percentage Difference			NC	**0%**	**0%**	NC	NC	NC	**7%**	NC	**2%**	NC	NC	NC	NC	NC	NC	NC
WC BLUE WREN CK-DS_18122023	18-Dec-23	Primary	< 0.05	**0.003**	**0.06**	< 0.0002	< 0.001	< 0.001	**6.5**	< 0.001	**0.57**	< 0.0001	-	< 0.001	-	-	-	< 0.005
QC01A_18122023	18-Dec-23	Triplicate	< 0.01	**0.004**	< 0.05	< 0.0001	< 0.001	< 0.001	**6.38**	< 0.001	**0.577**	< 0.0001	-	< 0.001	-	-	-	< 0.005
Relative Percentage Difference			NC	**29%**	**18%**	NC	NC	NC	**2%**	NC	**1%**	NC	NC	NC	NC	NC	NC	NC
WC IRONBARK CK-DS_17012024	17-Jan-24	Primary	< 0.05	**0.002**	**2.1**	< 0.0002	< 0.001	< 0.001	**0.11**	< 0.001	**0.45**	< 0.0001	-	< 0.001	-	-	-	< 0.005
QC01_17012024	17-Jan-24	Duplicate	< 0.05	**0.002**	**2.1**	**0.0002**	< 0.001	**0.001**	**0.1**	< 0.001	**0.44**	< 0.0001	-	< 0.001	-	-	-	< 0.005
Relative Percentage Difference			NC	**0%**	**0%**	**0%**	NC	**0%**	**10%**	NC	**2%**	NC	NC	NC	NC	NC	NC	NC
WC IRONBARK CK-DS_17012024	17-Jan-24	Primary	< 0.05	**0.002**	**2.1**	< 0.0002	< 0.001	< 0.001	**0.11**	< 0.001	**0.45**	< 0.0001	-	< 0.001	-	-	-	< 0.005
QC01A_17012024	17-Jan-24	Triplicate	< 0.01	< 0.001	**2.25**	< 0.0001	< 0.001	< 0.001	< 0.05	< 0.001	**0.462**	< 0.0001	-	< 0.001	-	-	-	< 0.005
Relative Percentage Difference			NC	**67%**	**7%**	NC	NC	NC	**75%**	NC	**3%**	NC	NC	NC	NC	NC	NC	NC

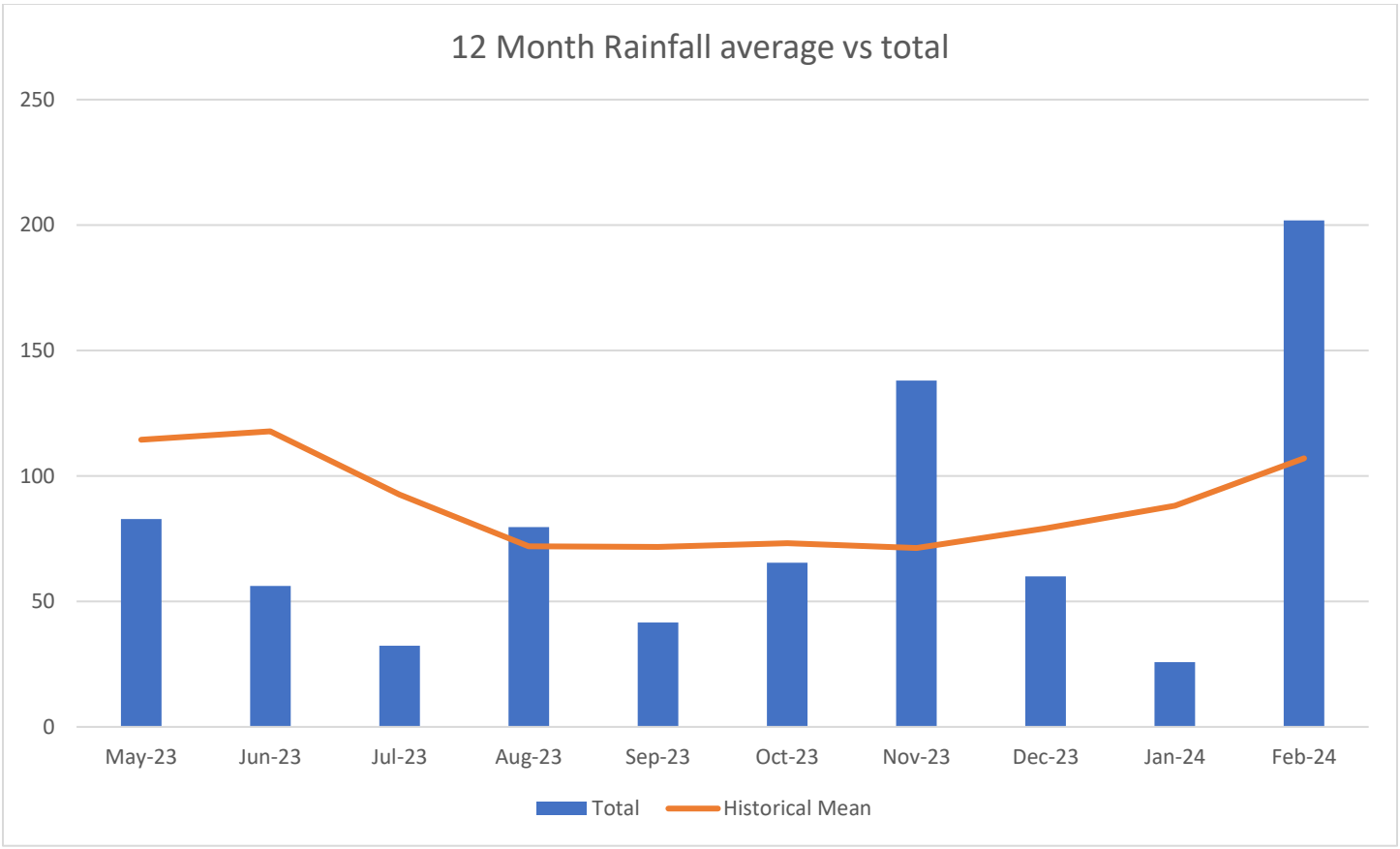
Notes:
- - Not analysed
< - Less than laboratory limit of reporting
NC - Not calculated
mg/L - Milligrams per litre
RPD - Relative Percentage Difference

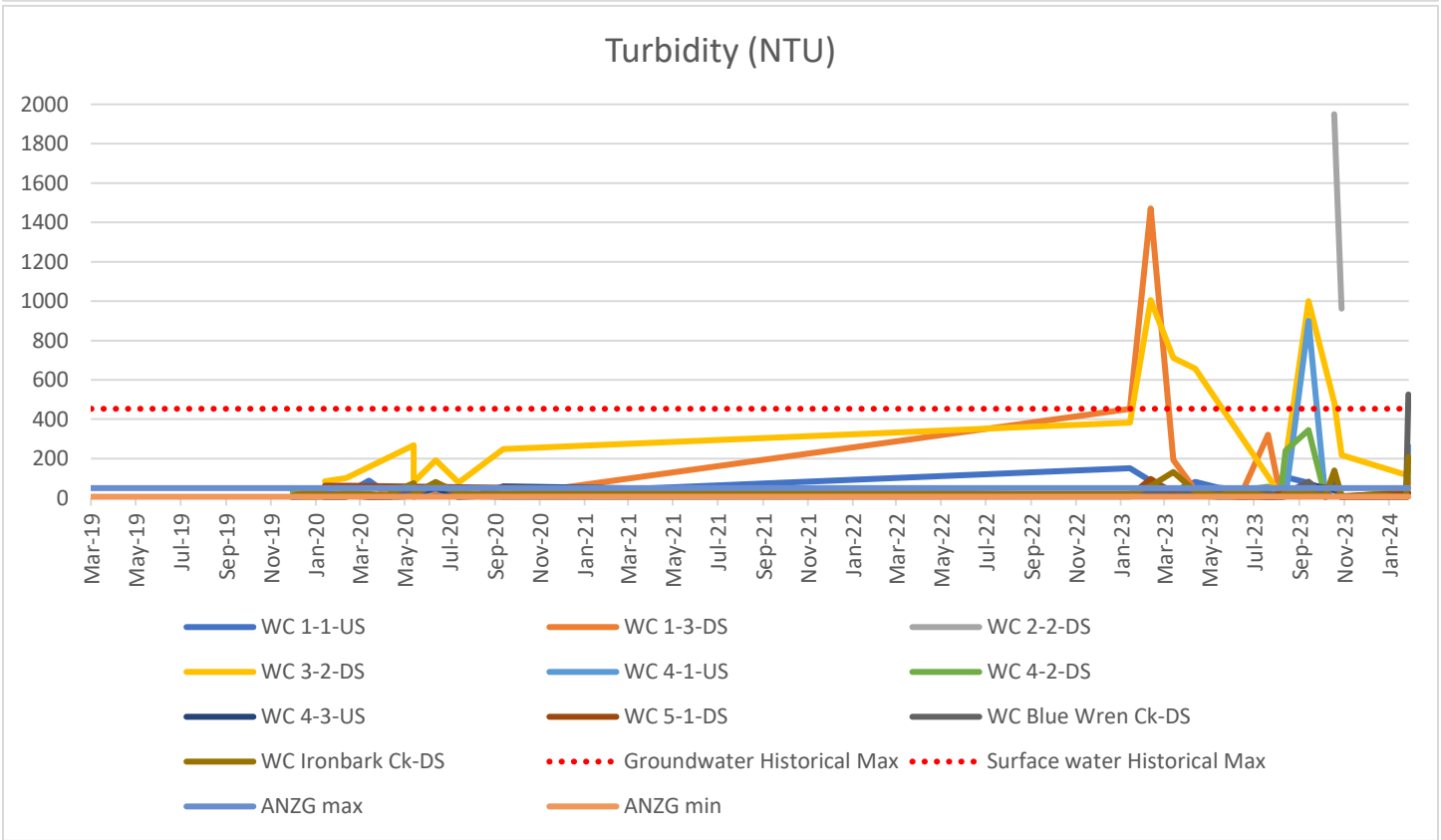
Table 3
QAQC - Rinsate Blanks

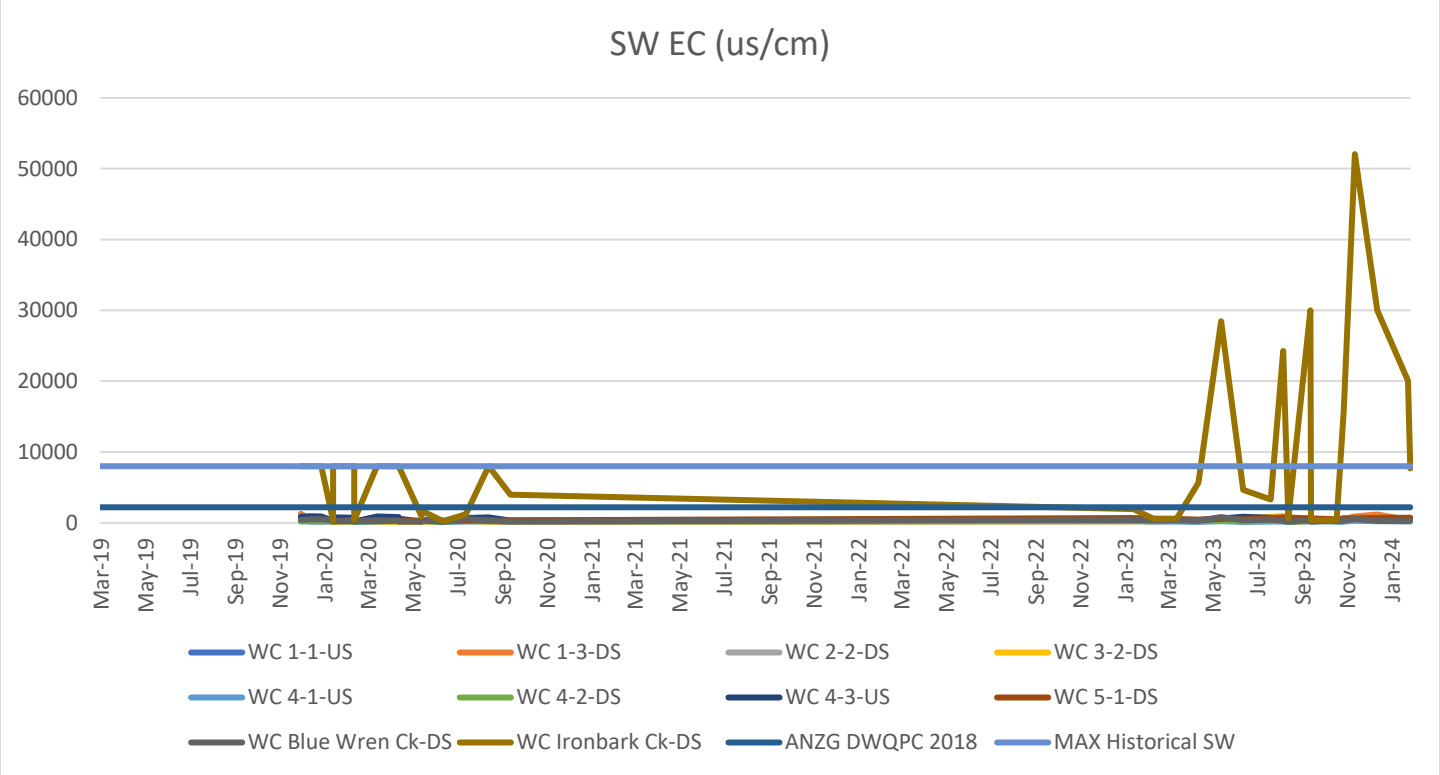
Analyte			Metals										
			Aluminum	Arsenic	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample Name	Sample Date	Sample Type												
RB01_21042023	21-Apr-23	Rinsate	< 0.01	< 0.001	< 0.05	< 0.0001	< 0.001	< 0.001	< 0.05	< 0.001	< 0.001	< 0.0001	< 0.001	< 0.005
RB01_17052023	17-May-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB02_18052023	18-May-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB03_19052023	19-May-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	**0.001**	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB01_30062023	30-Jun-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_260723_26072023	26-Jul-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB01_08082023	08-Aug-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB01_24082023	24-Aug-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB02_25082023	25-Aug-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB-280923_28092023	28-Sep-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_251023_25102023	25-Oct-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_371023_27102023	27-Oct-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_061123_06112023	06-Nov-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_161123_16112023	16-Nov-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_171123_17112023	17-Nov-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_181223_18122023	18-Dec-23	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005
RB_170124_17012024	17-Jan-24	Rinsate	< 0.05	< 0.001	< 0.05	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005

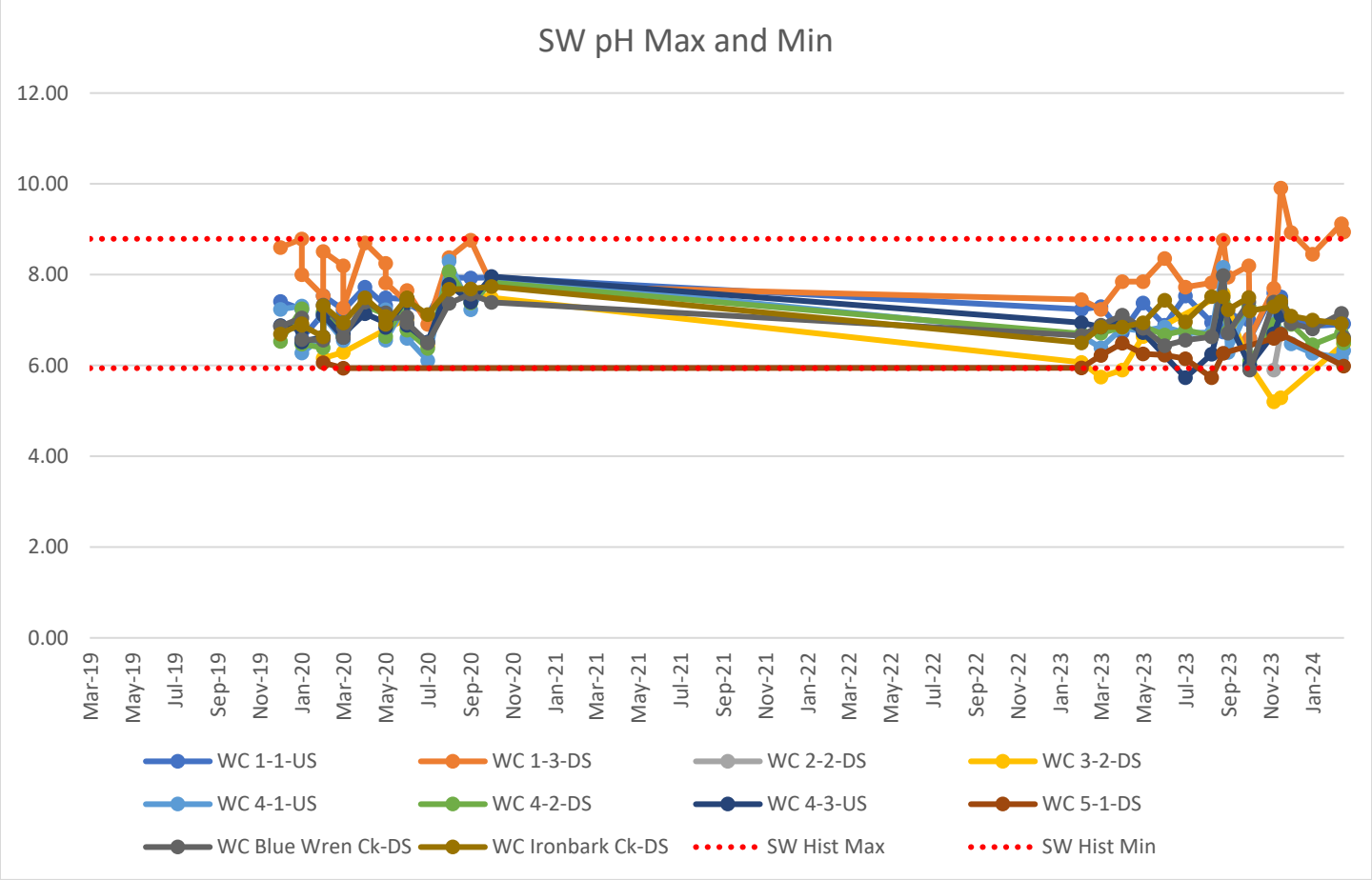
Notes:
< - Less than laboratory limit of reporting
mg/L - Milligrams per litre

APPENDIX C TRENDS

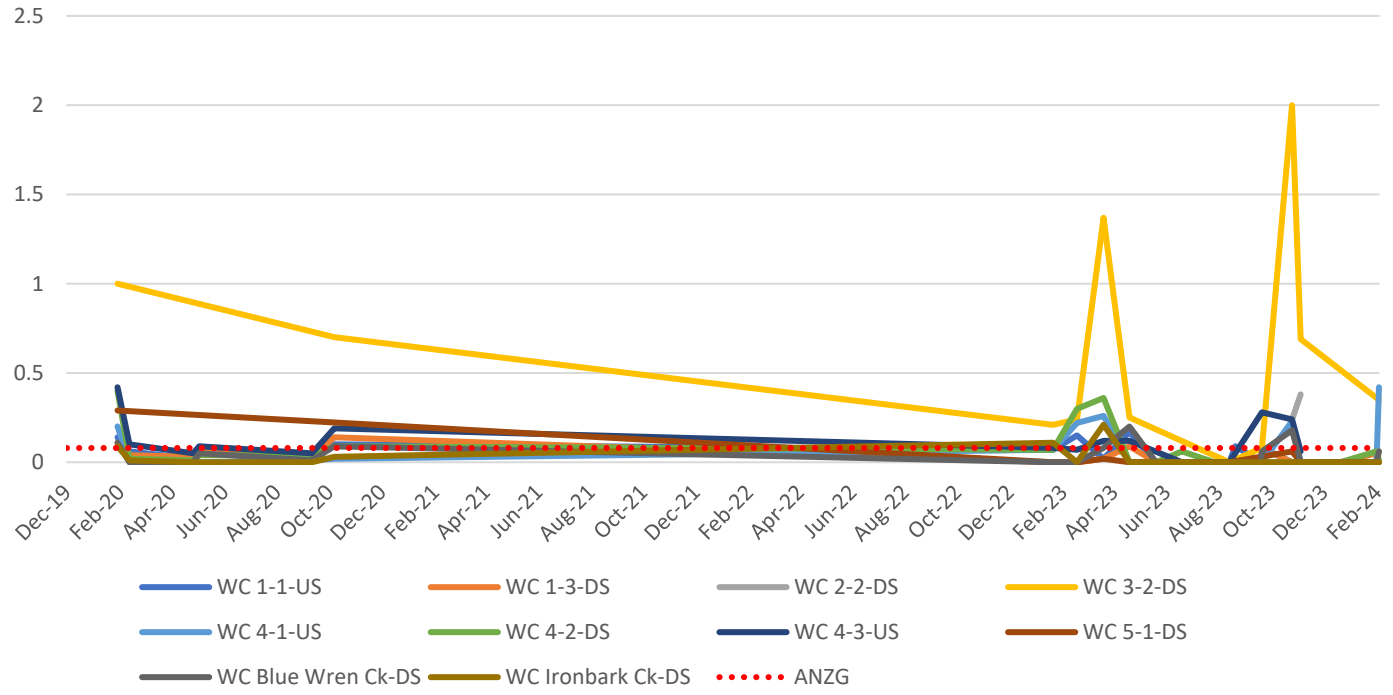

12 Month Rainfall average vs total
250
200
150
100
50
0
May-23
Jun-23
Jul-23
Aug-23
Sep-23
Oct-23
Nov-23
Dec-23
Jan-24
Feb-24
Total
Historical Mean


Turbidity (NTU)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
Groundwater Historical Max
Surface water Historical Max
ANZG max
ANZG min

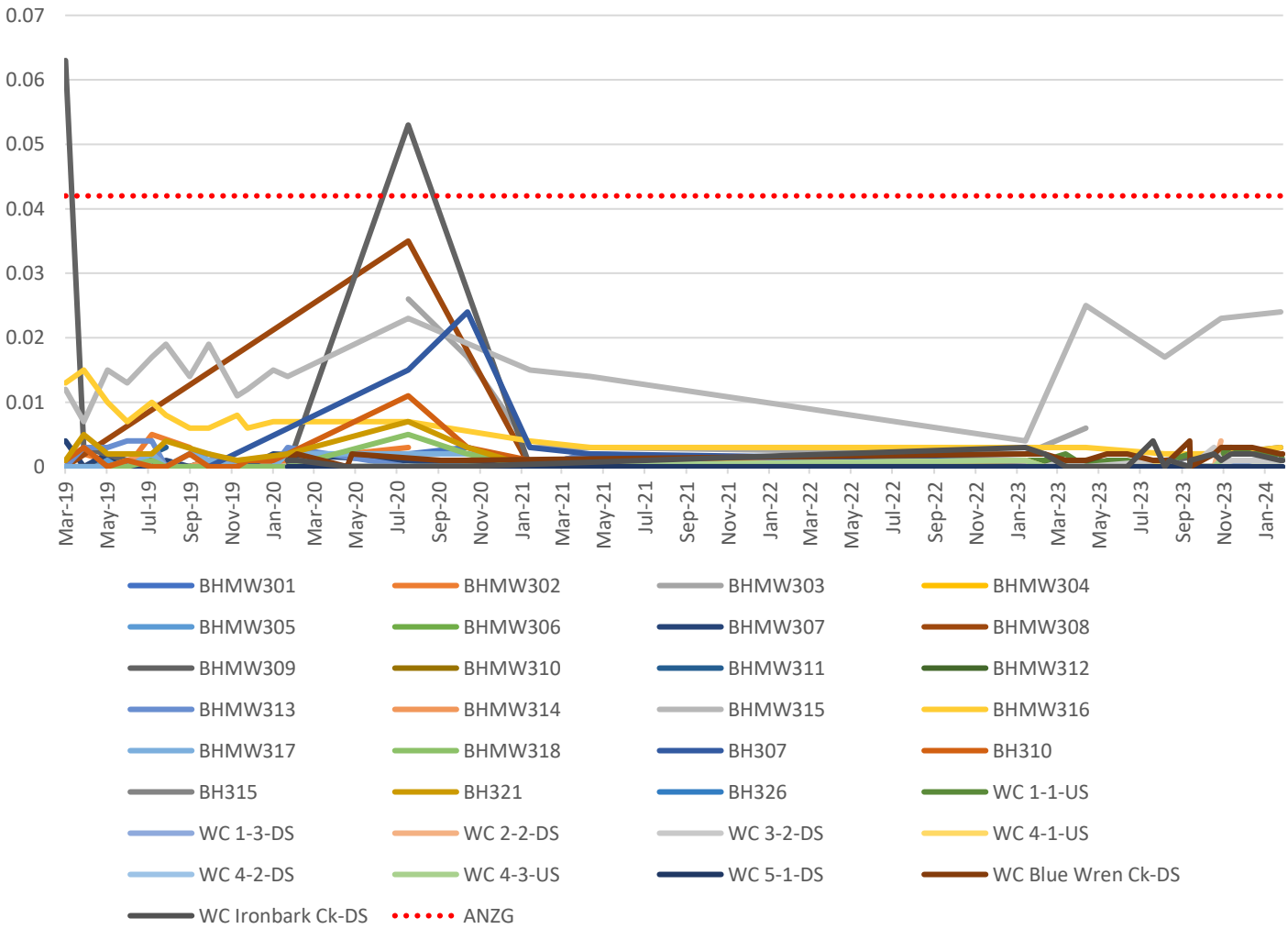

SW EC (us/cm)
60000
50000
40000
30000
20000
10000
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG DWQPC 2018
MAX Historical SW

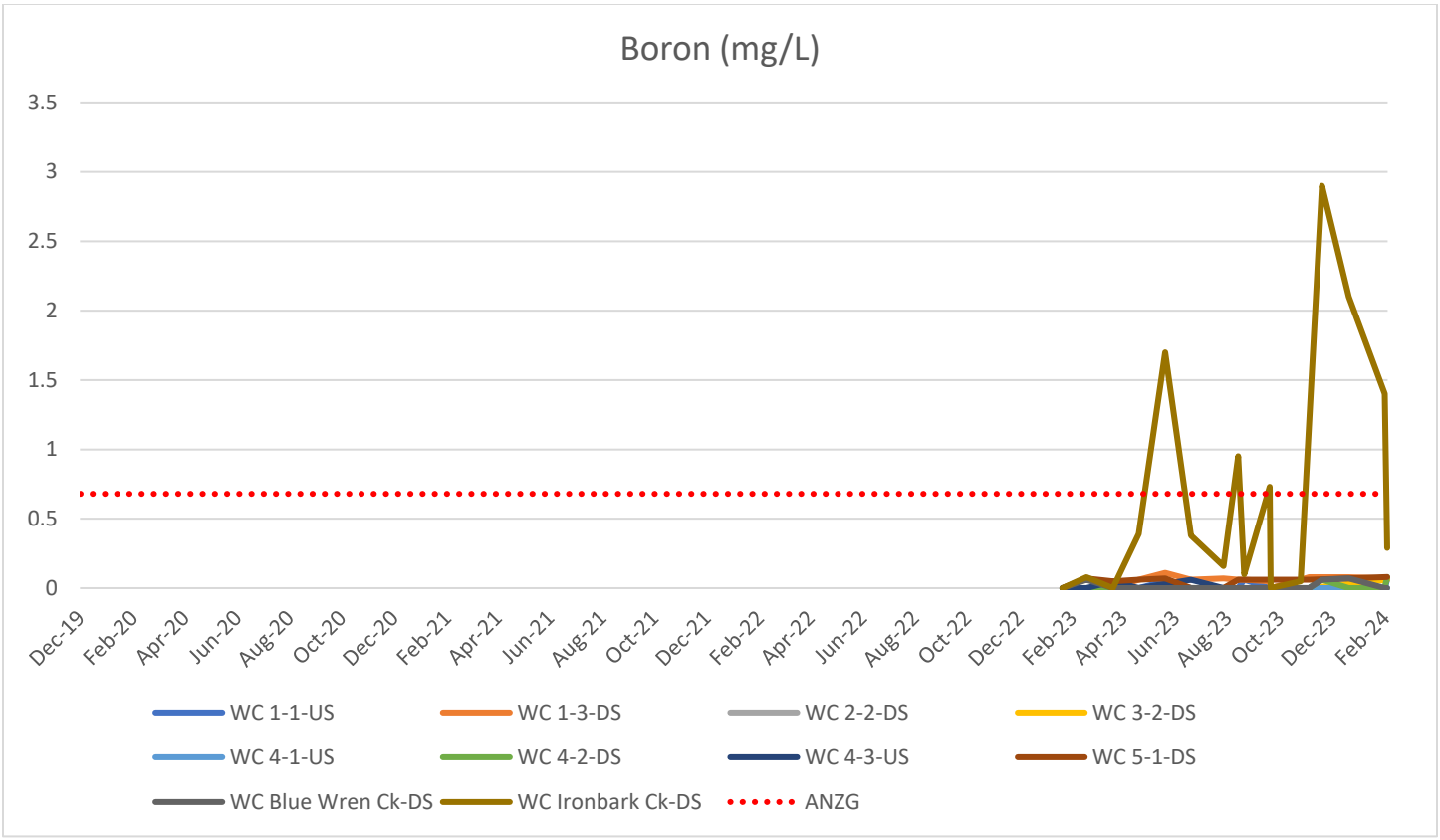

SW pH Max and Min
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
SW Hist Max
SW Hist Min

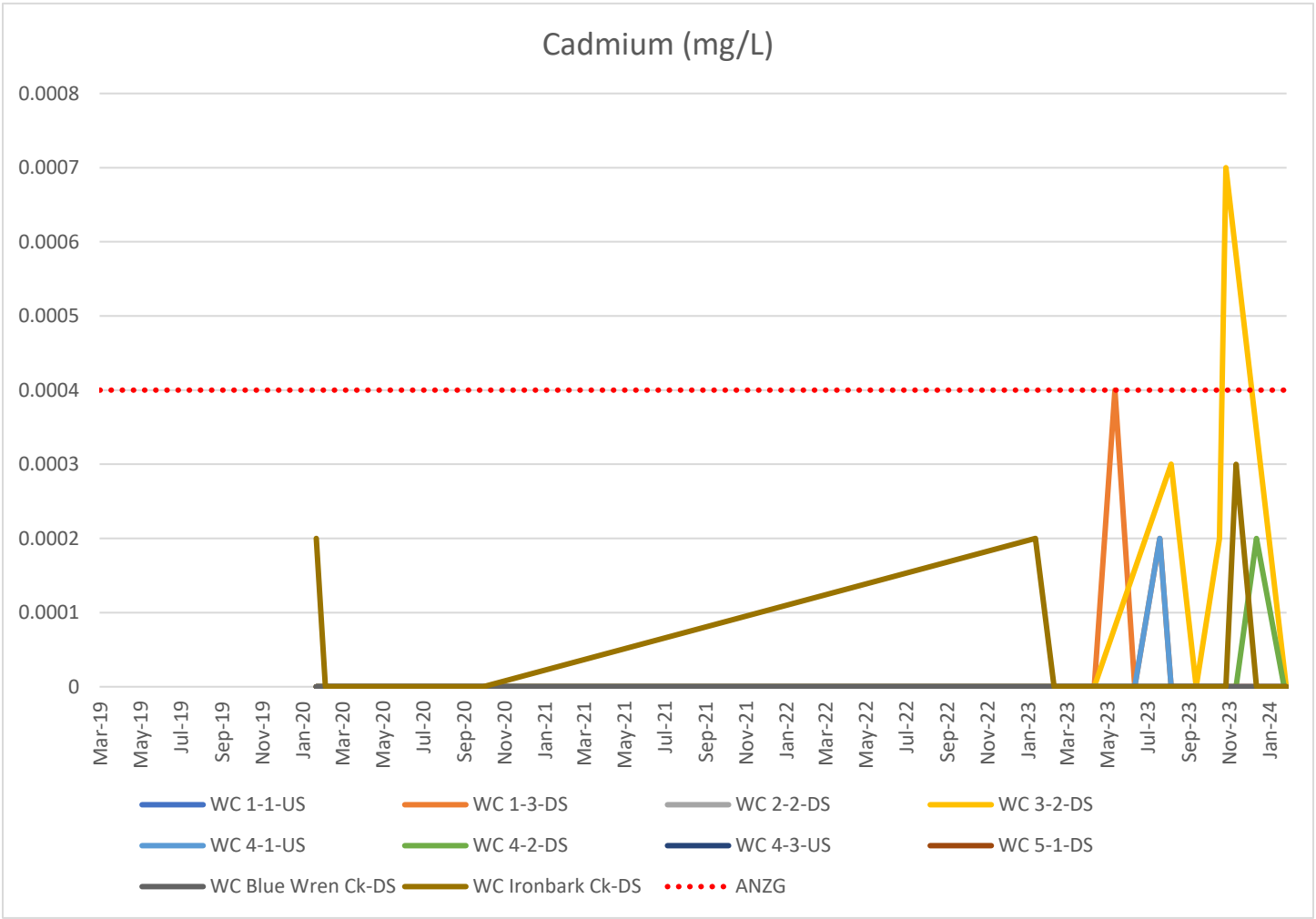
Aluminium (mg/L)

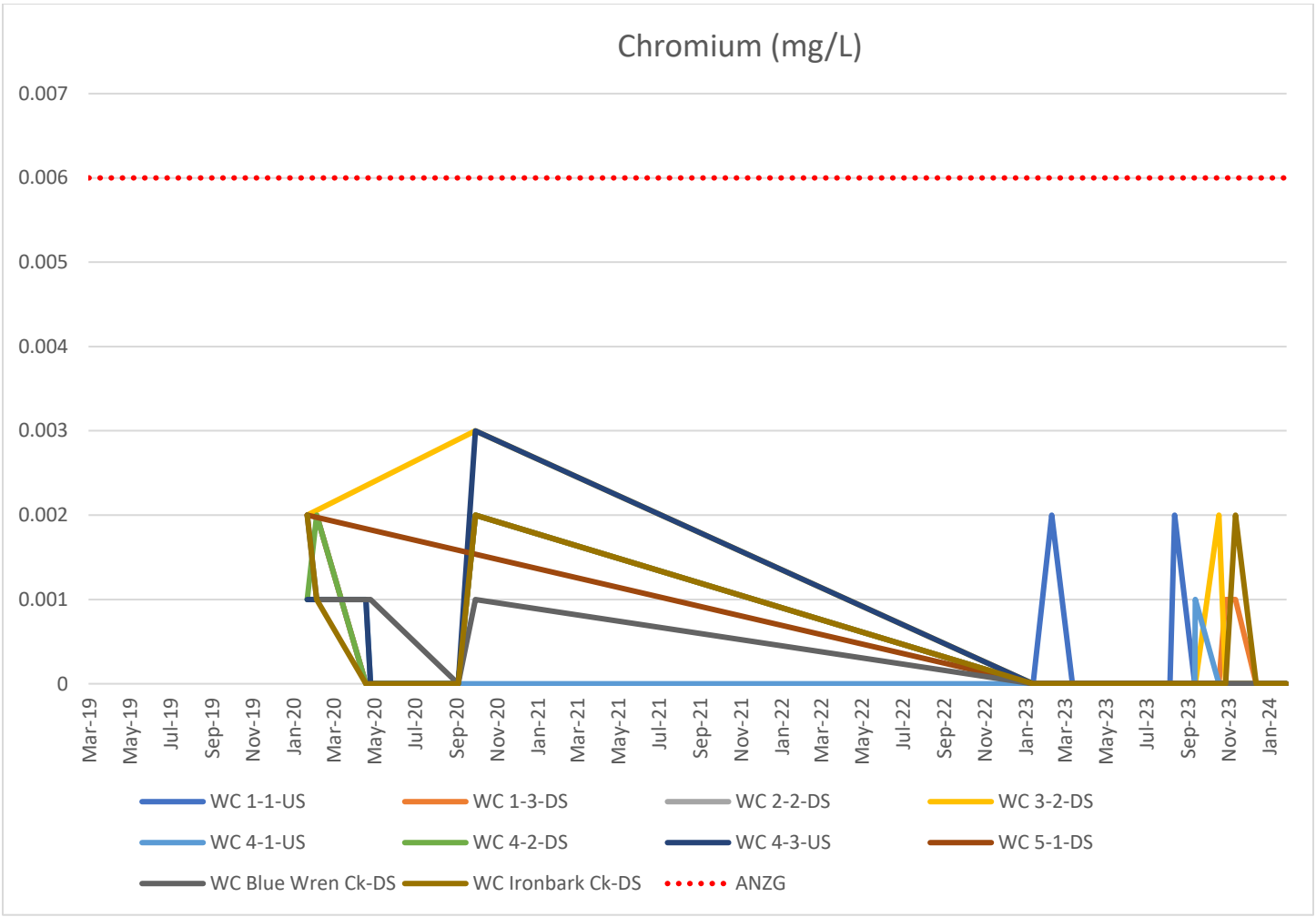


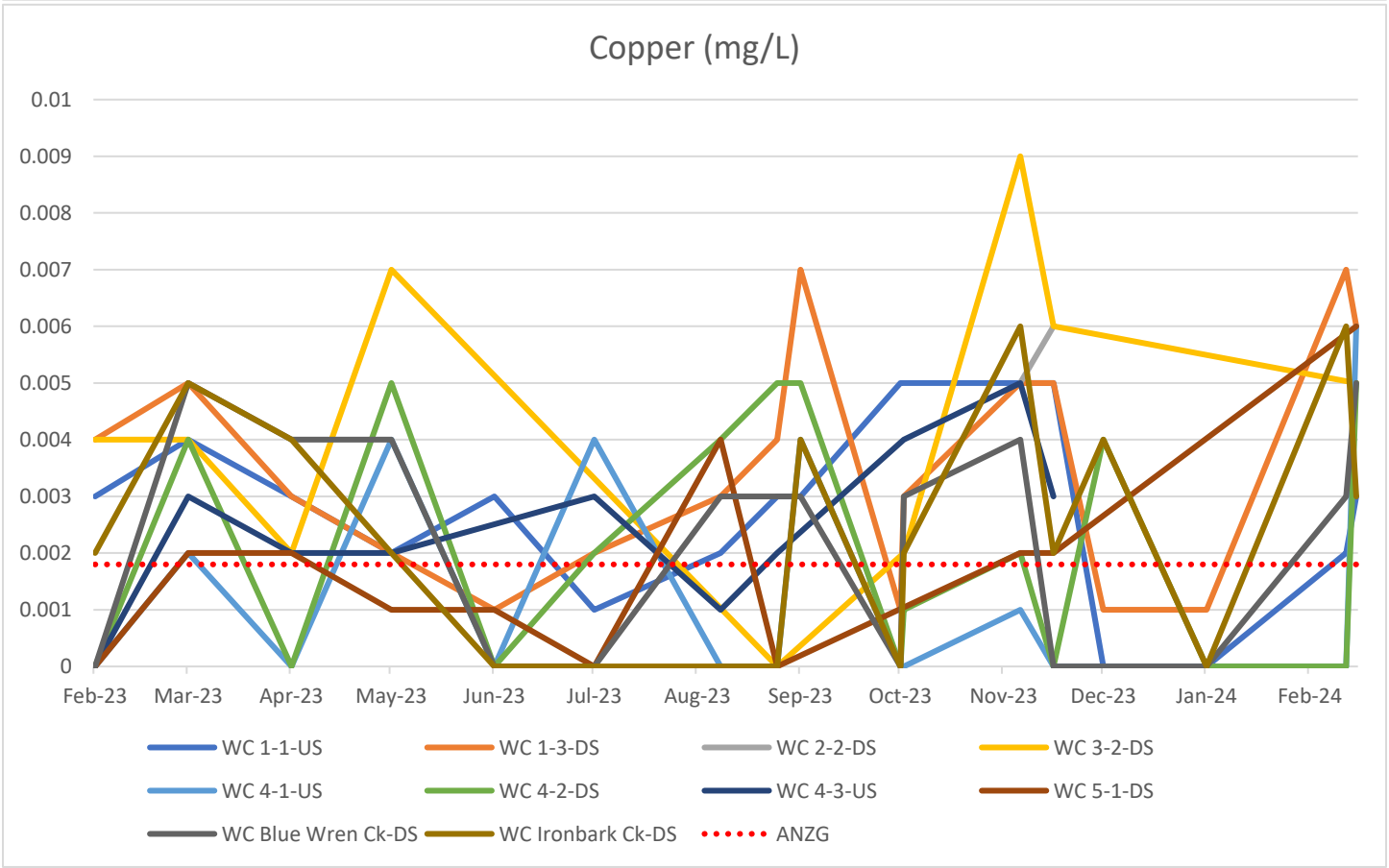
Arsenic (mg/L)

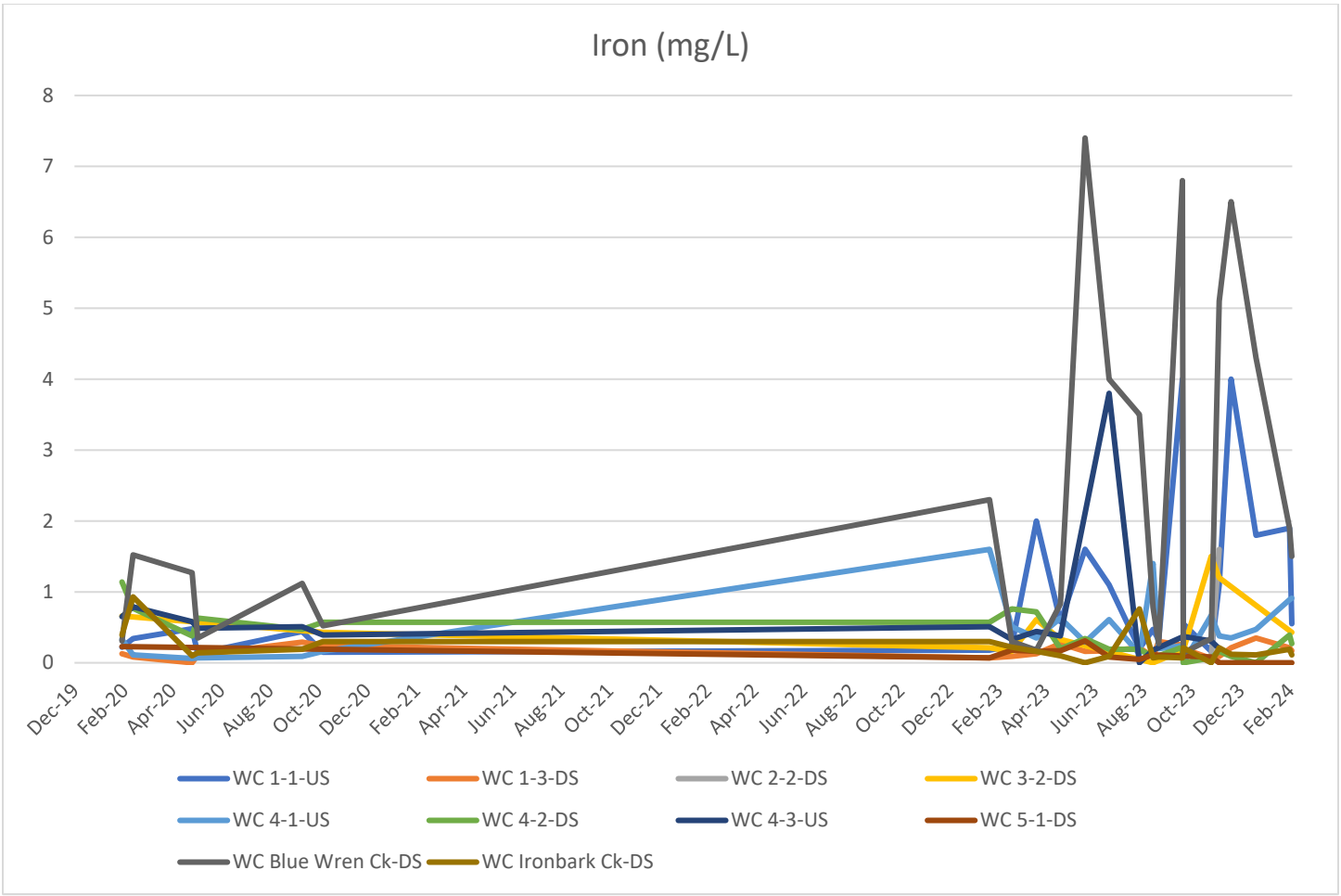


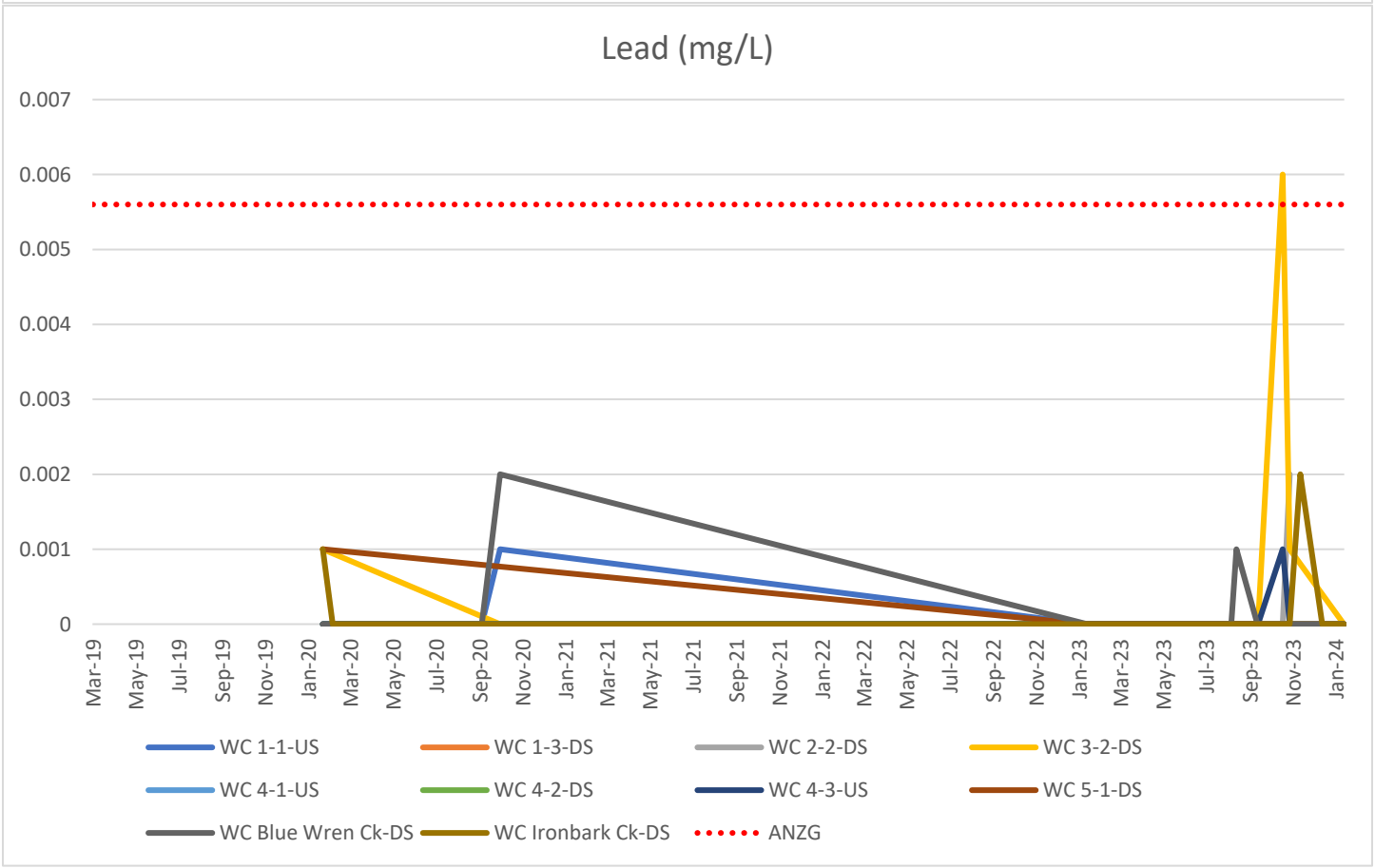

Boron (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
Dec-19
Feb-20
Apr-20
Jun-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
Aug-21
Oct-21
Dec-21
Feb-22
Apr-22
Jun-22
Aug-22
Oct-22
Dec-22
Feb-23
Apr-23
Jun-23
Aug-23
Oct-23
Dec-23
Feb-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

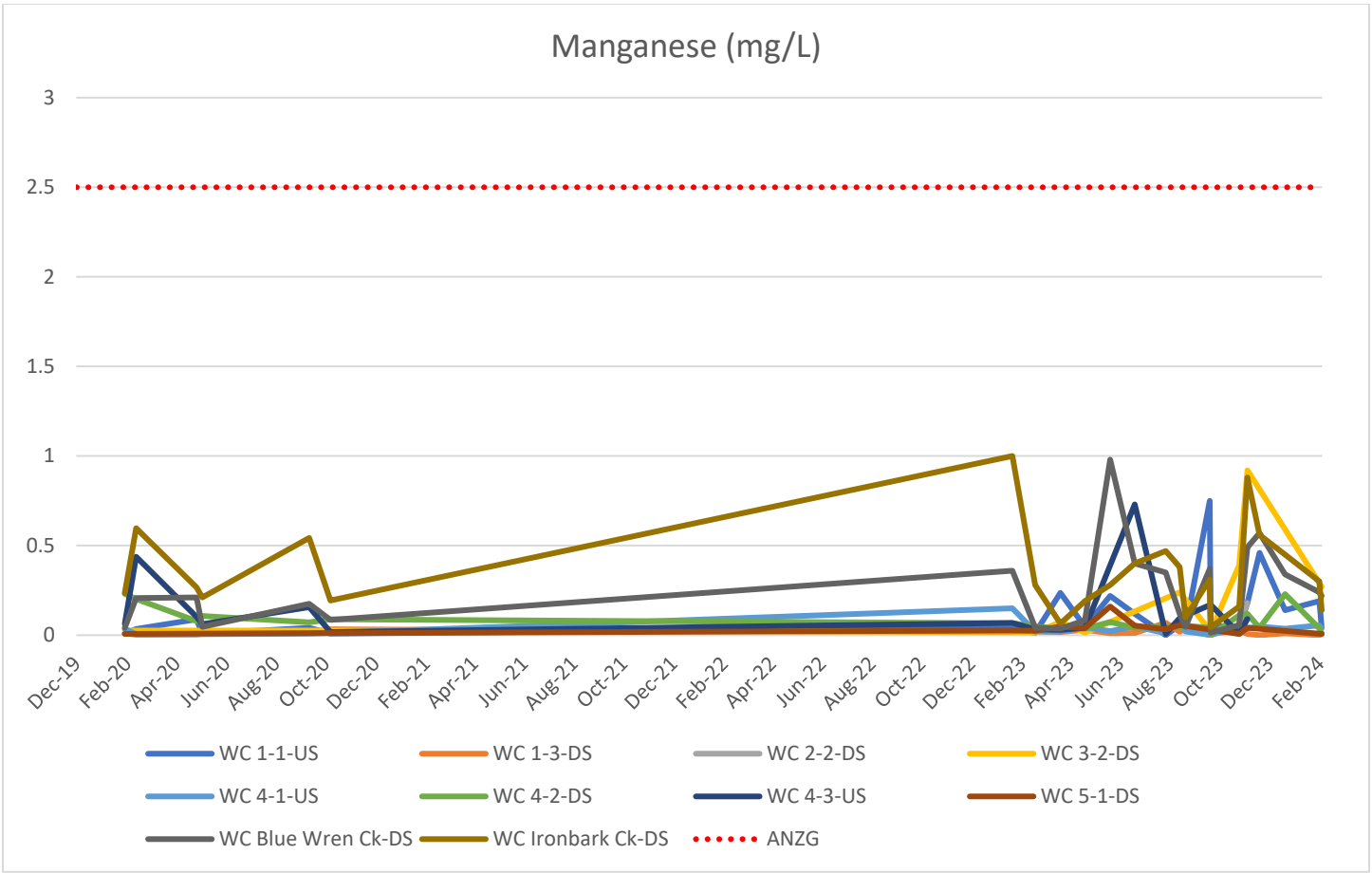

Cadmium (mg/L)
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

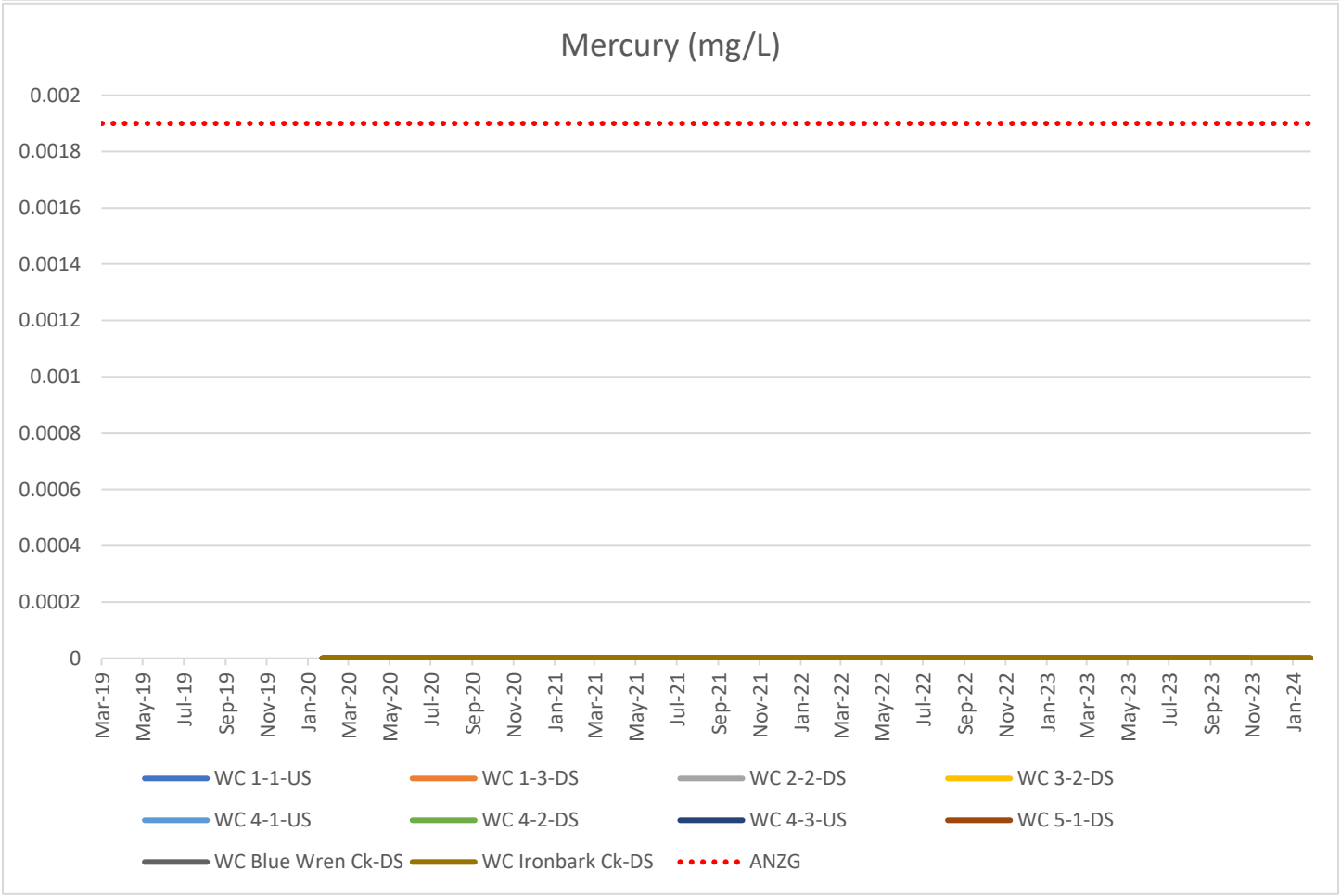

Chromium (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

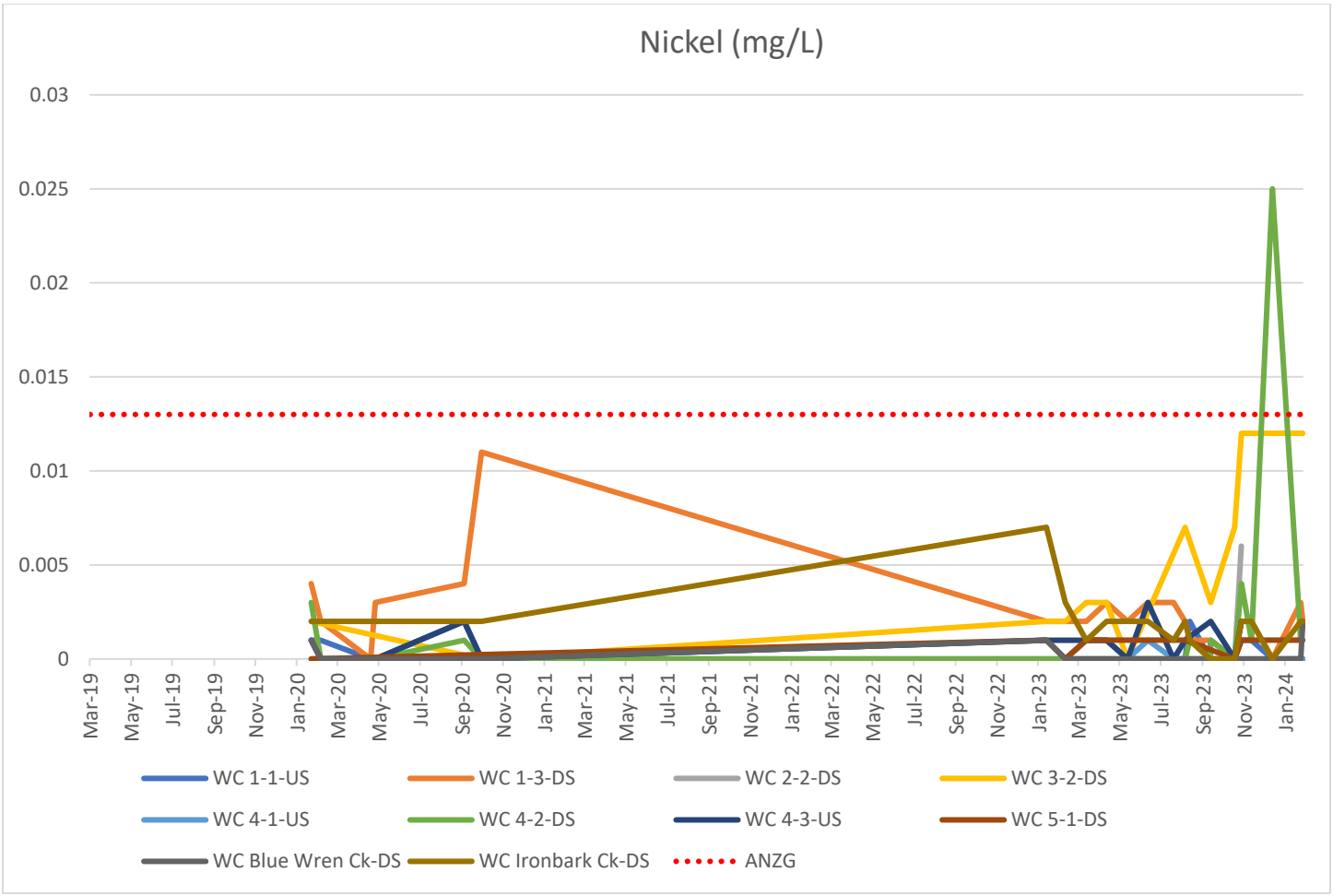

Copper (mg/L)
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Feb-23
Mar-23
Apr-23
May-23
Jun-23
Jul-23
Aug-23
Sep-23
Oct-23
Nov-23
Dec-23
Jan-24
Feb-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

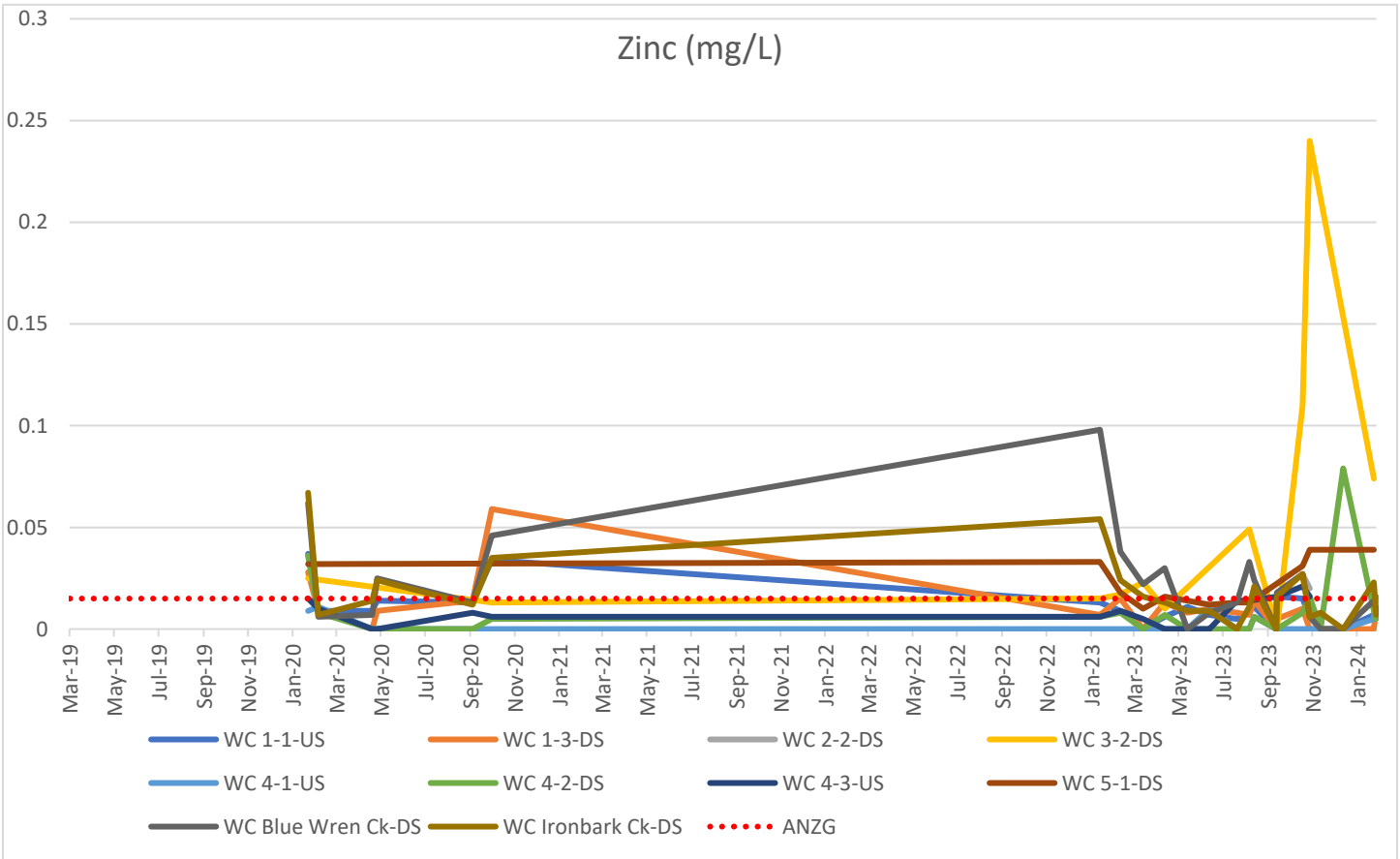

Iron (mg/L)
8
7
6
5
4
3
2
1
0
Dec-19
Feb-20
Apr-20
Jun-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
Aug-21
Oct-21
Dec-21
Feb-22
Apr-22
Jun-22
Aug-22
Oct-22
Dec-22
Feb-23
Apr-23
Jun-23
Aug-23
Oct-23
Dec-23
Feb-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS

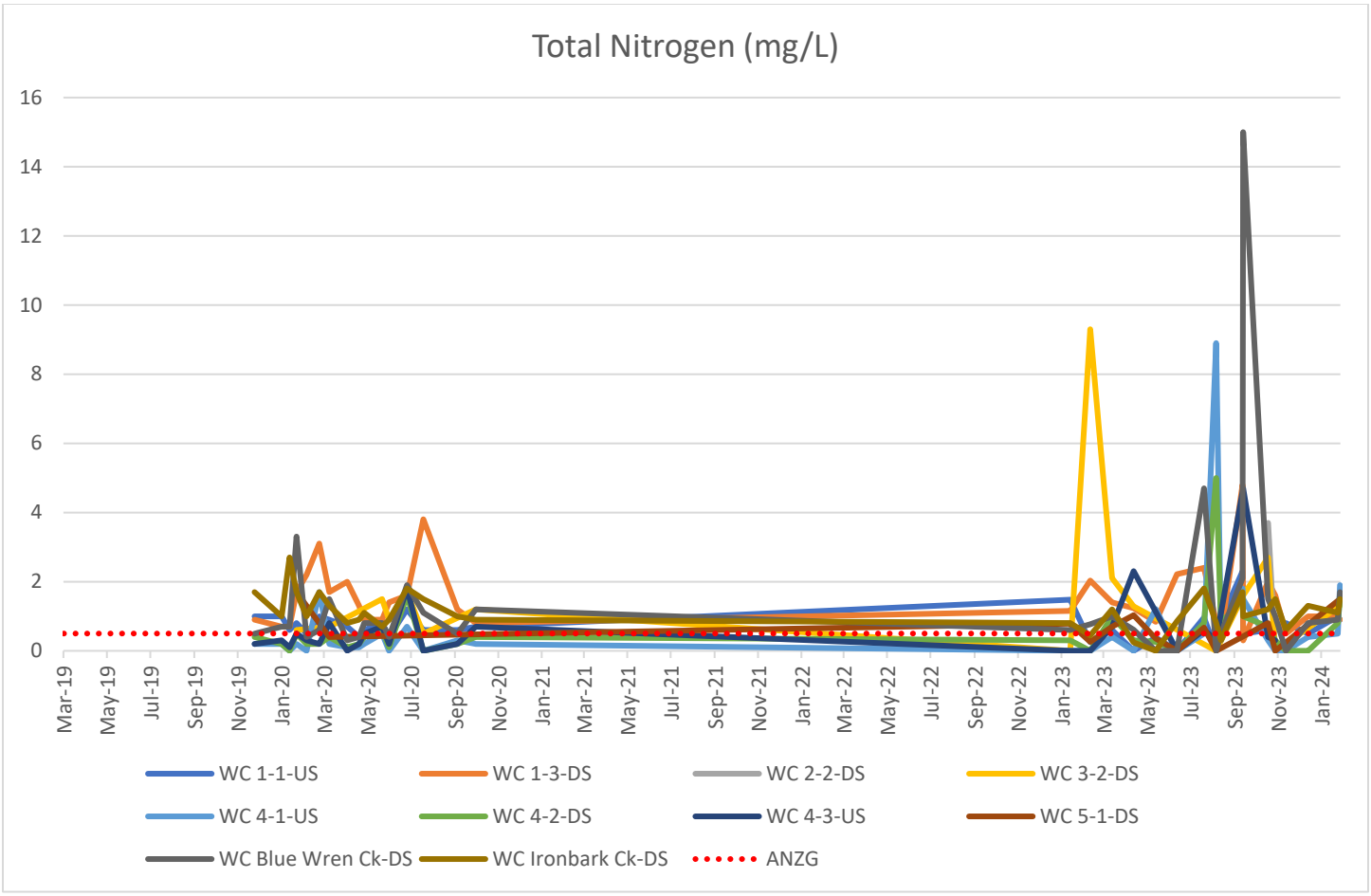

Lead (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

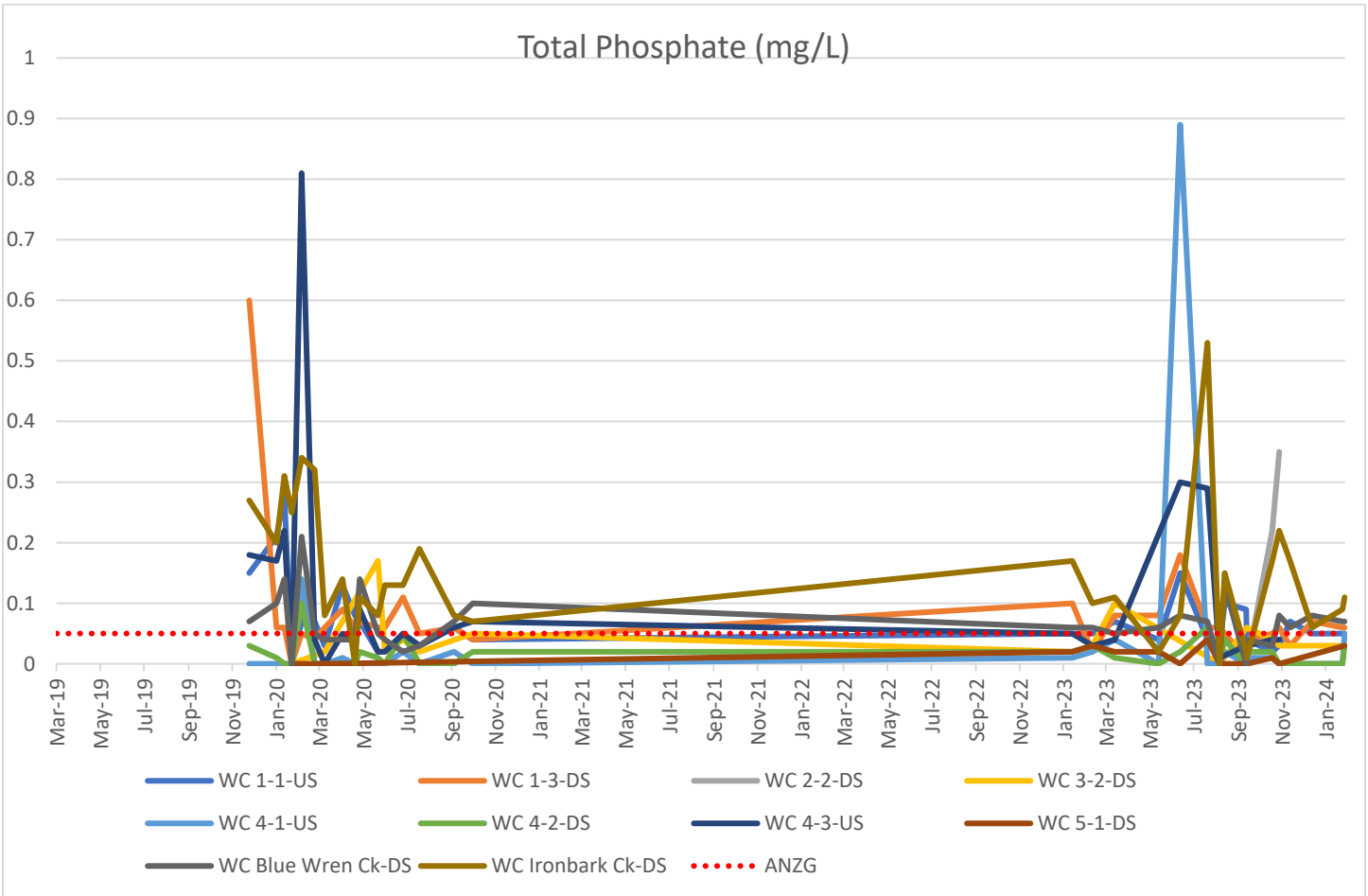

Manganese (mg/L)
3
2.5
2
1.5
1
0.5
0
Dec-19
Feb-20
Apr-20
Jun-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
Aug-21
Oct-21
Dec-21
Feb-22
Apr-22
Jun-22
Aug-22
Oct-22
Dec-22
Feb-23
Apr-23
Jun-23
Aug-23
Oct-23
Dec-23
Feb-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG


Mercury (mg/L)
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

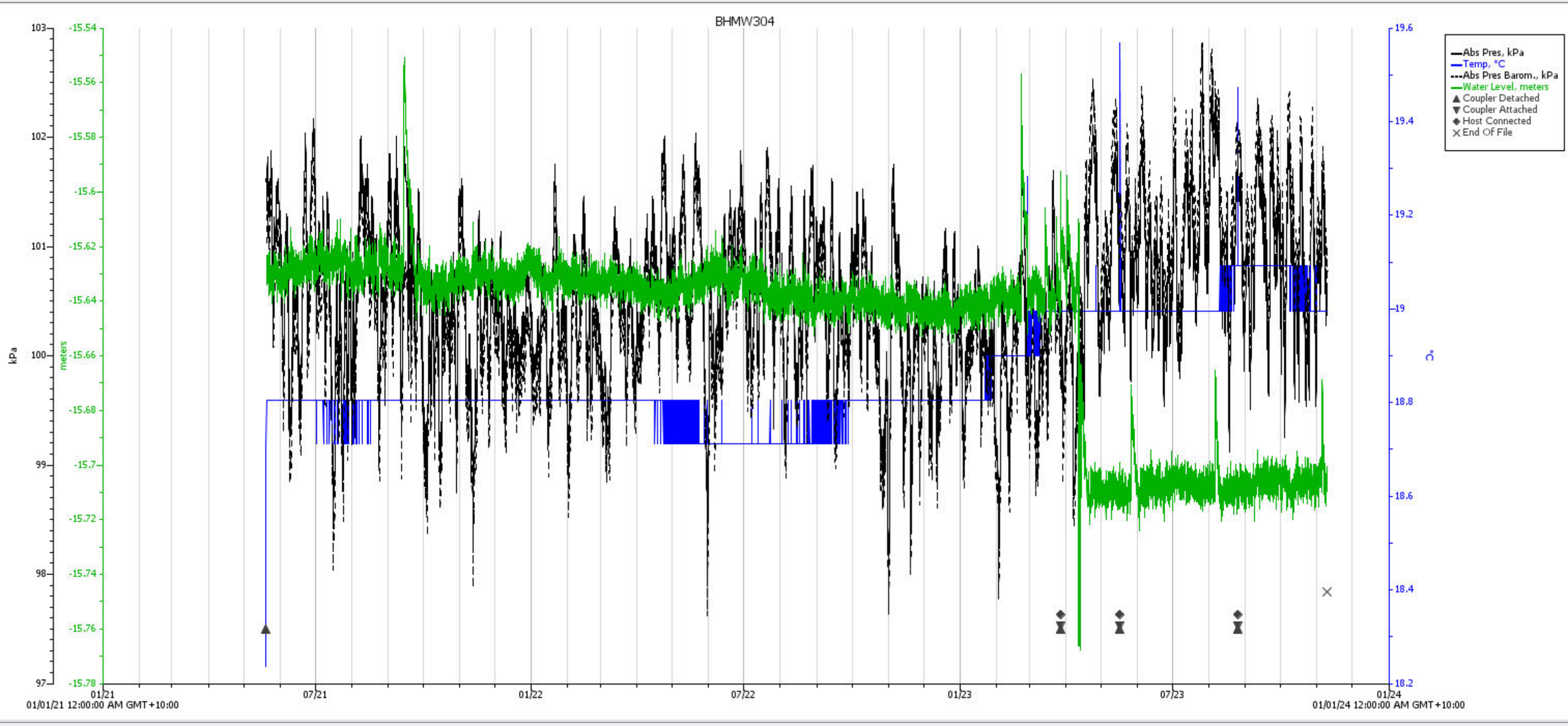

Nickel (mg/L)
0.03
0.025
0.02
0.015
0.01
0.005
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG


Zinc (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG


Total Nitrogen (mg/L)
16
14
12
10
8
6
4
2
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG


Total Phosphate (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
WC 1-1-US
WC 1-3-DS
WC 2-2-DS
WC 3-2-DS
WC 4-1-US
WC 4-2-DS
WC 4-3-US
WC 5-1-DS
WC Blue Wren Ck-DS
WC Ironbark Ck-DS
ANZG

APPENDIX D GROUNDWATER ELEVATION DATA LOGGER INFORMATION


BHMW304
kPa
meters
°C
Abs Pres, kPa
Temp, °C
Abs Pres Barom., kPa
Water Level, meters
Coupler Detached
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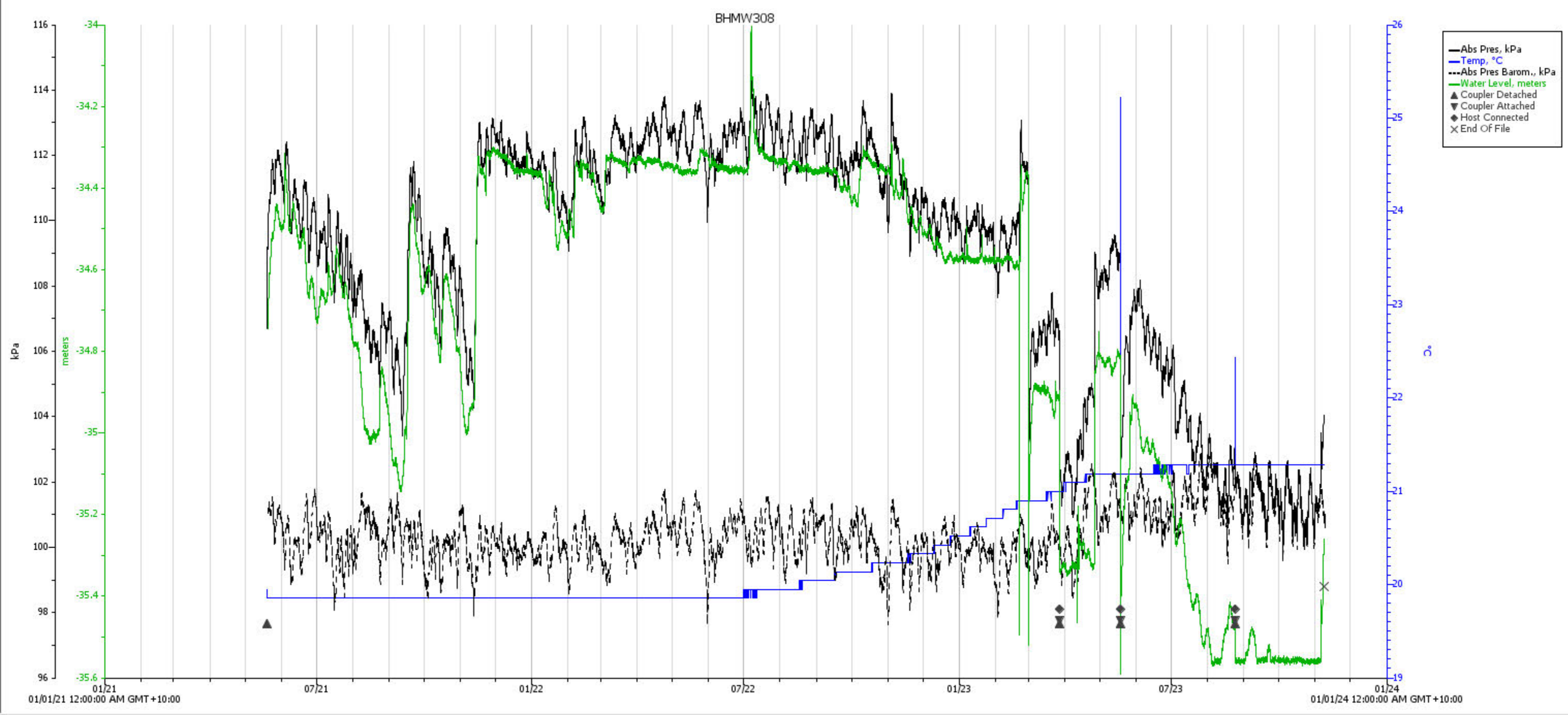
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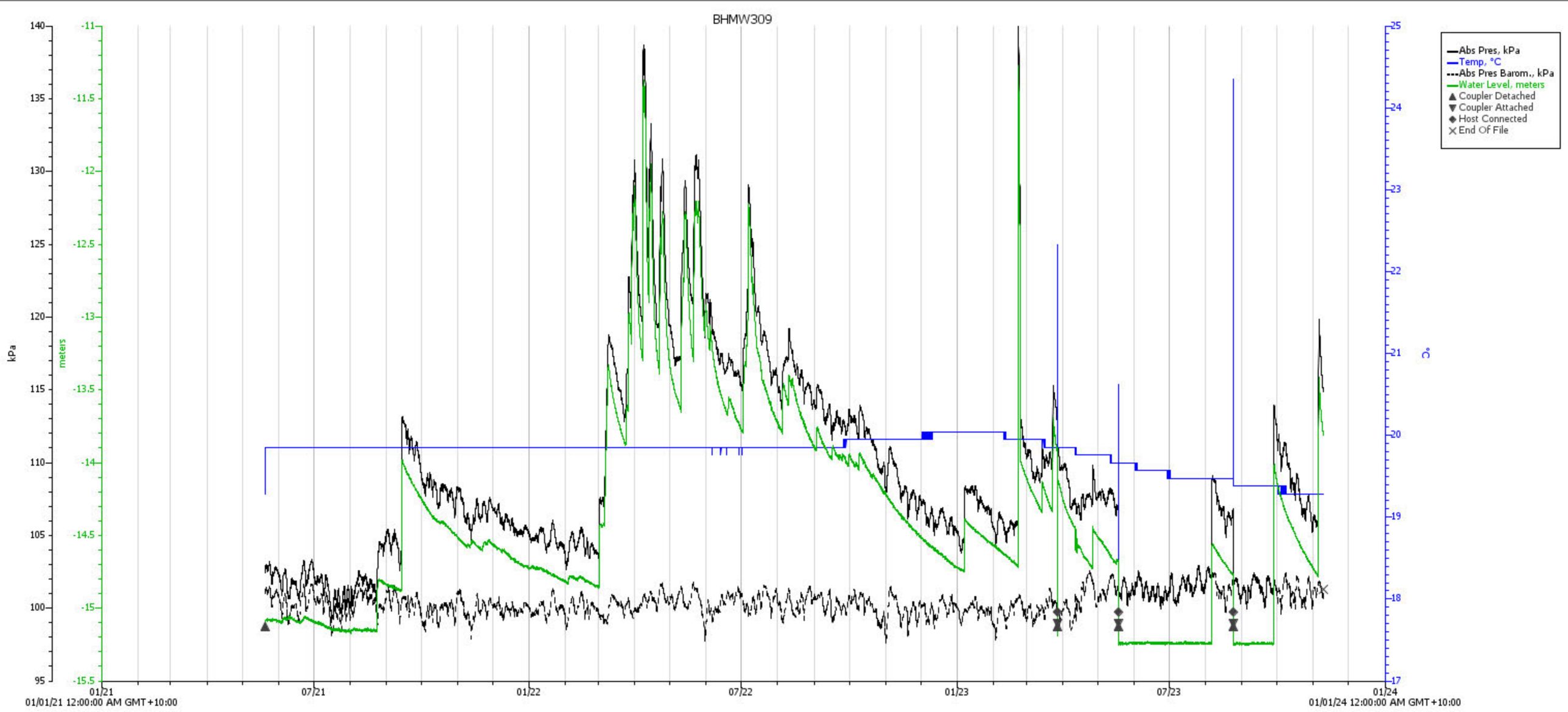
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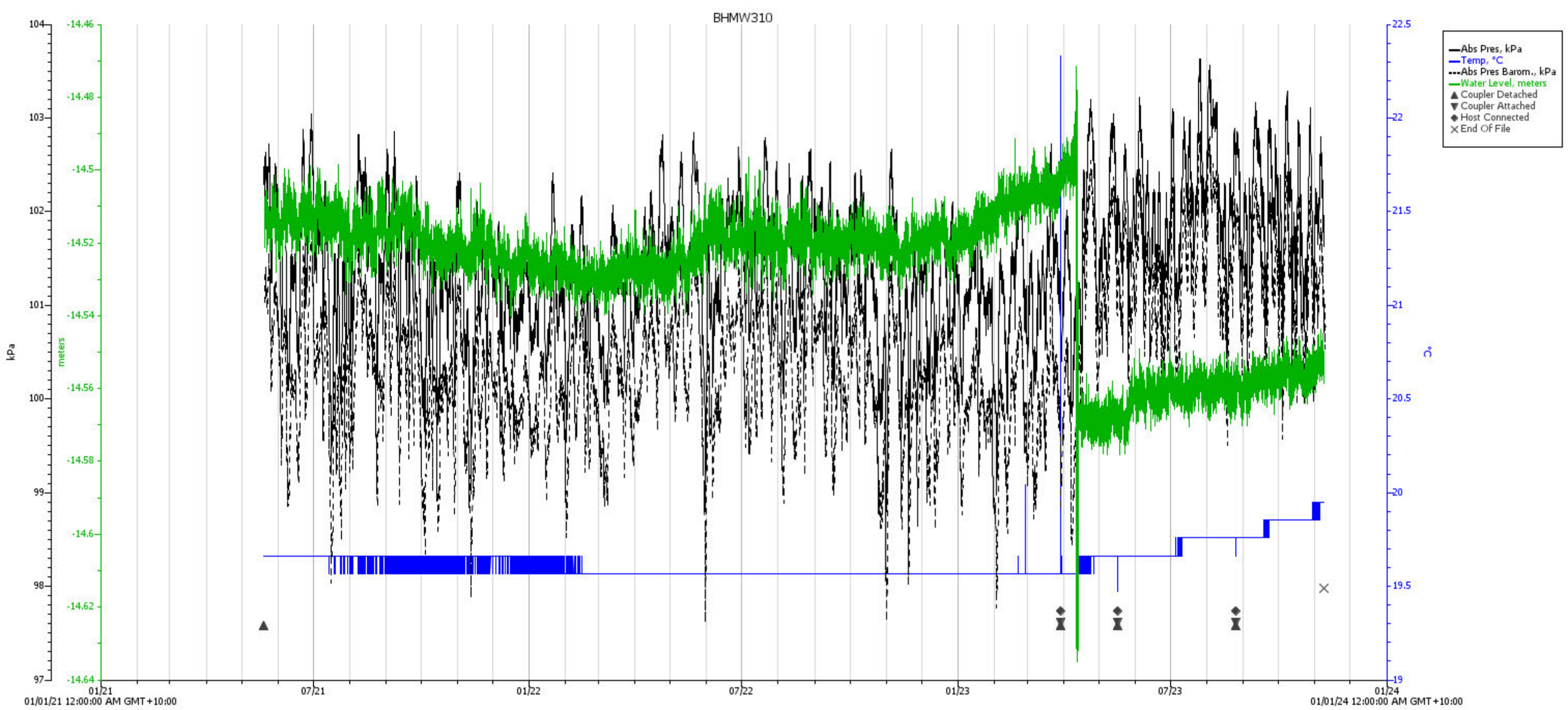
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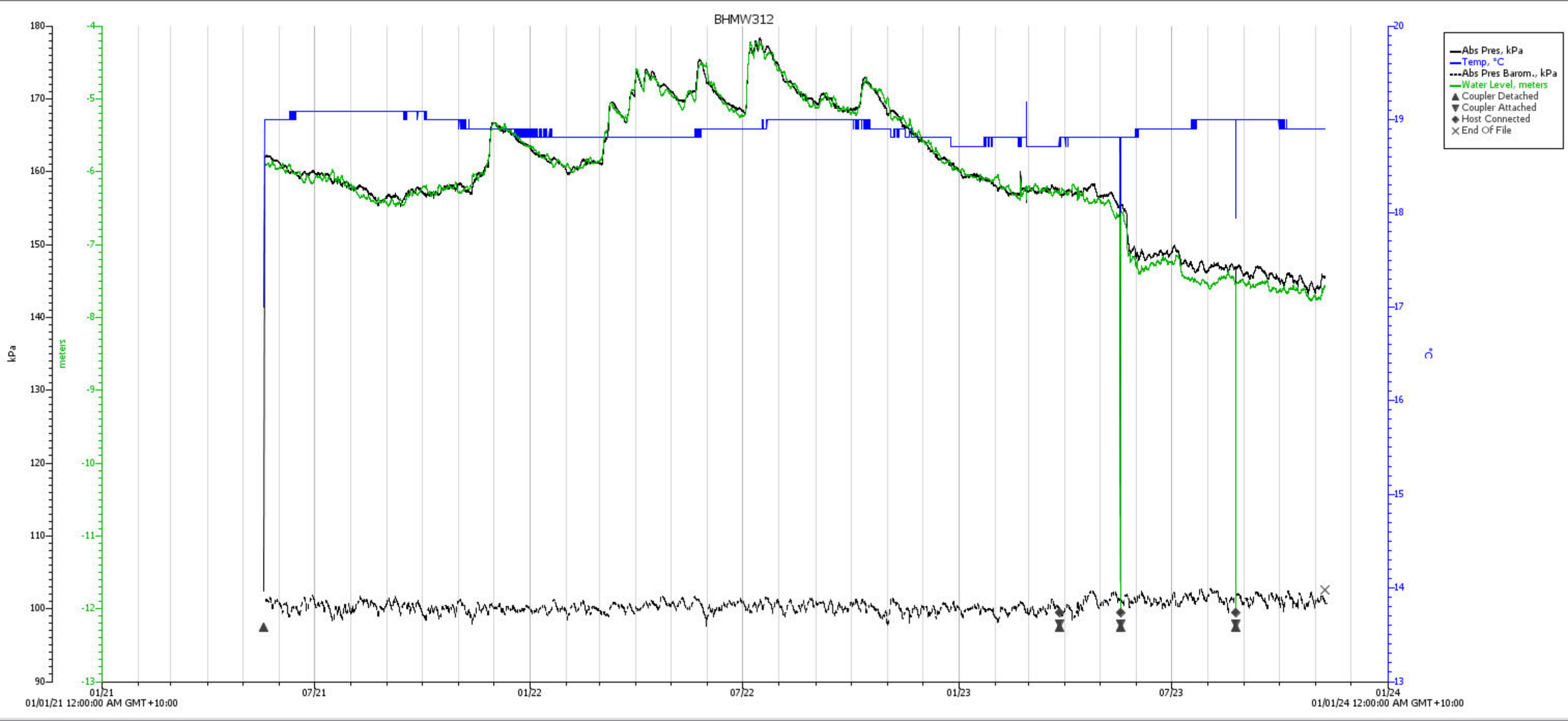
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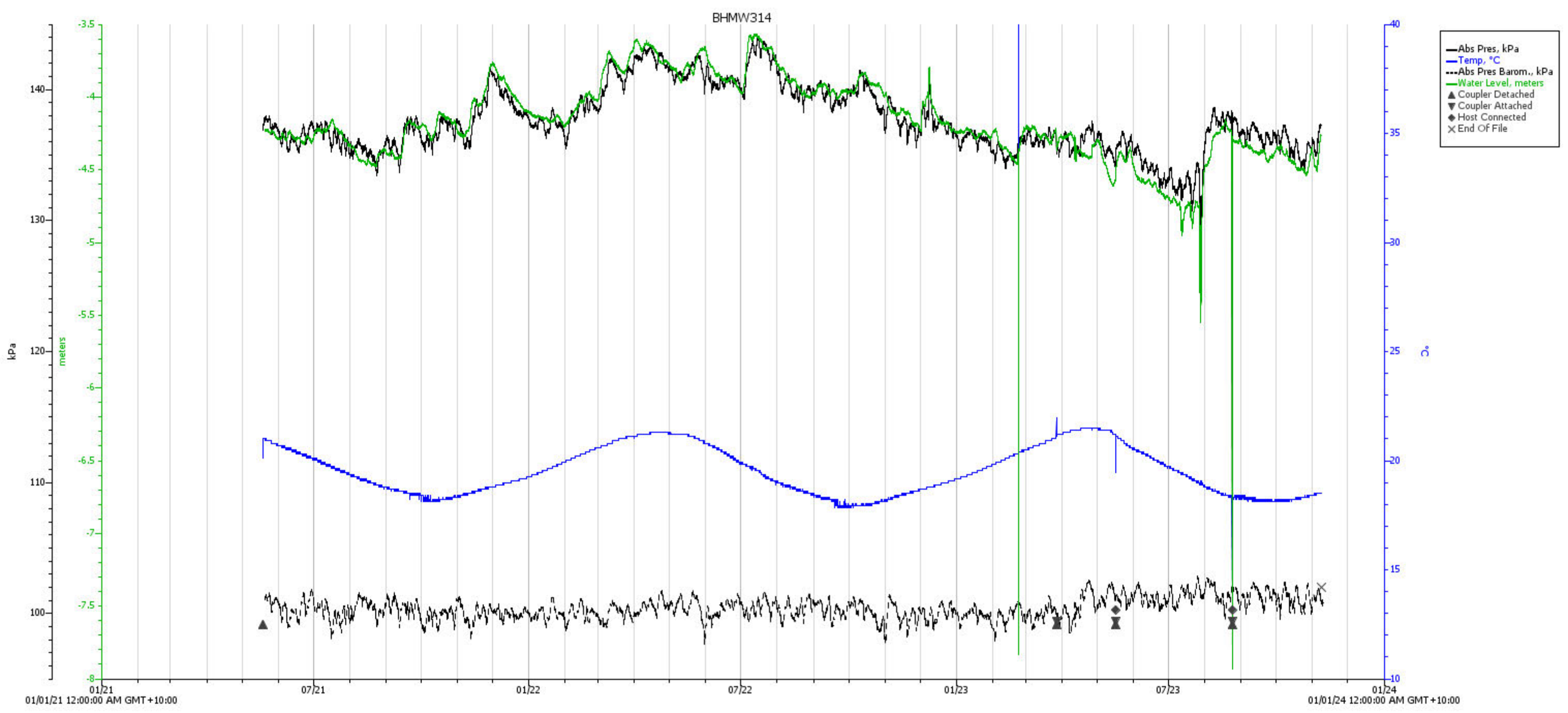
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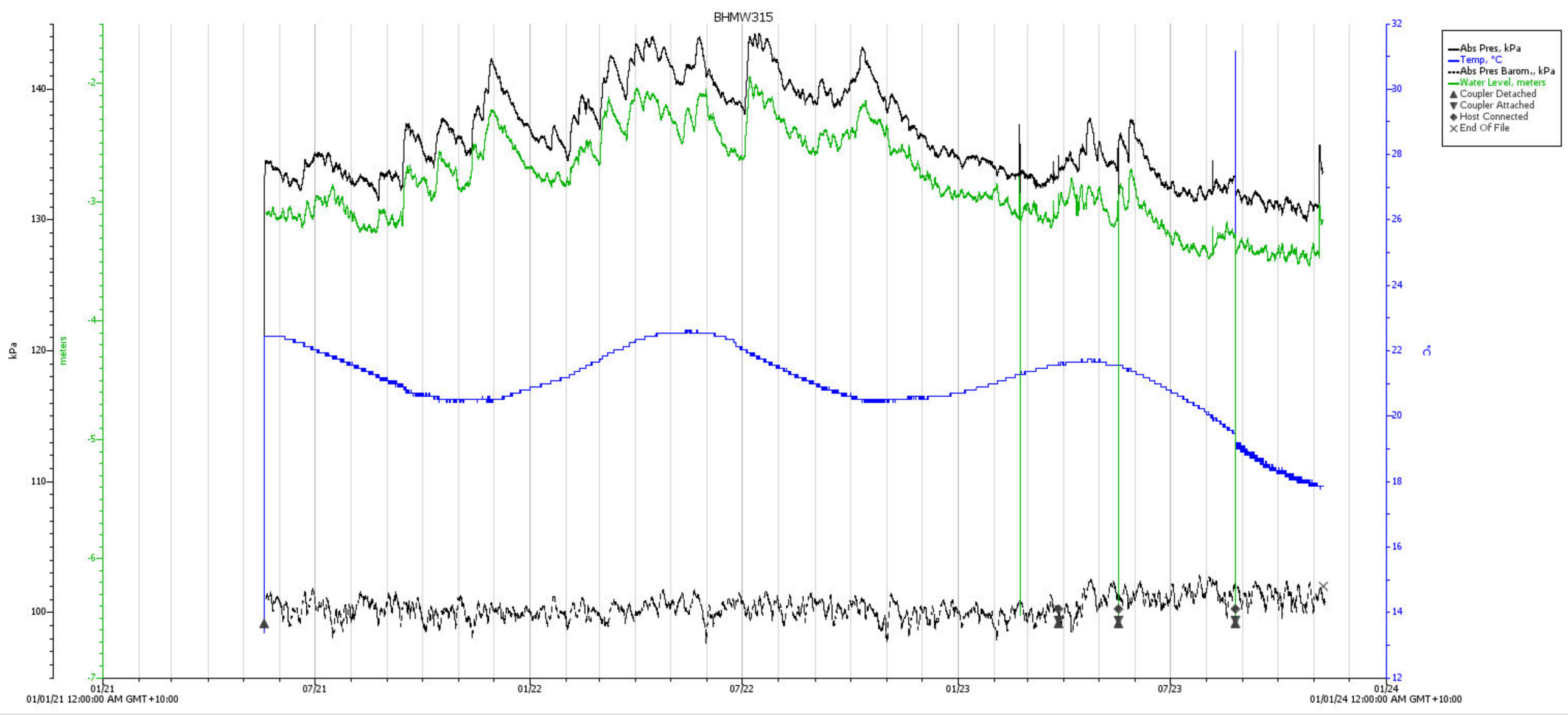
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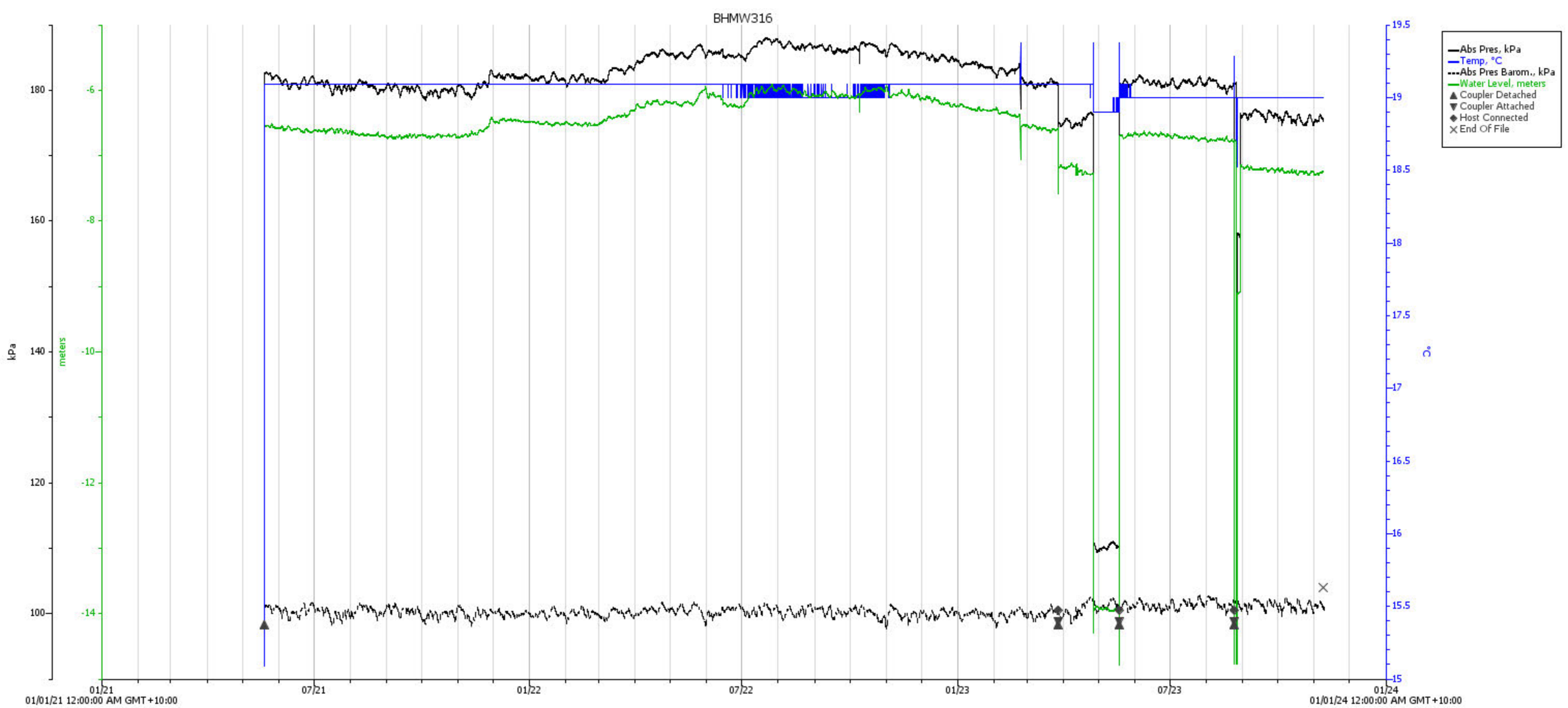
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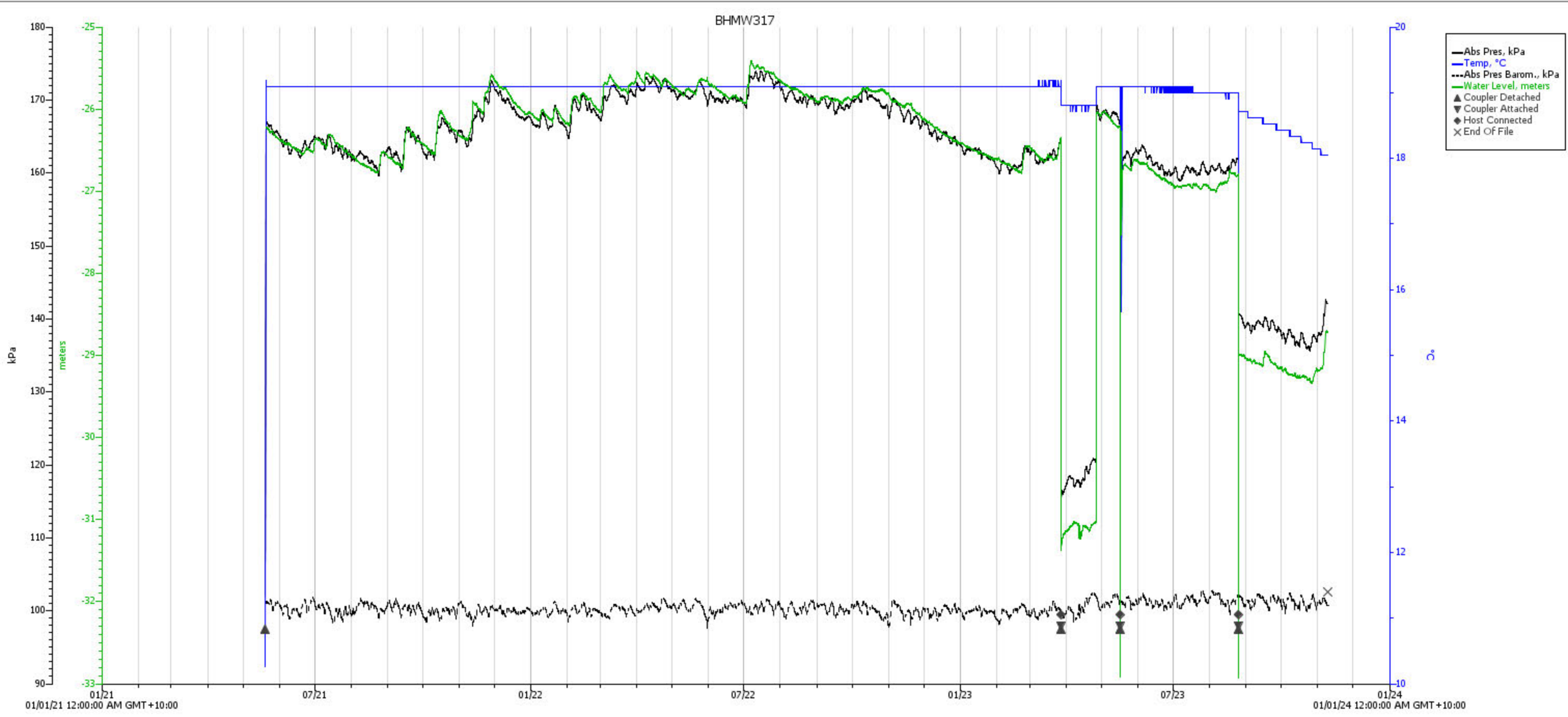
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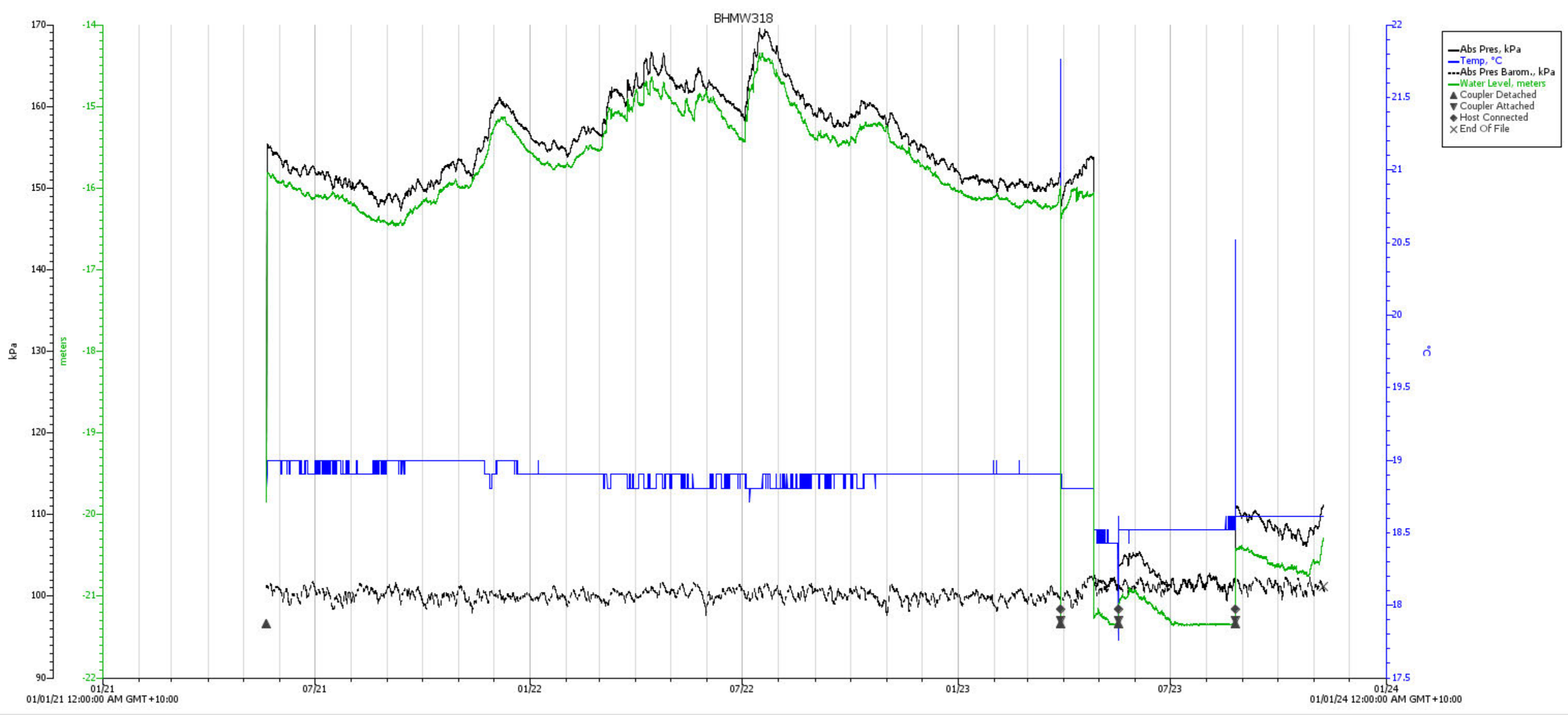
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Appendix C Noise and vibration monitoring results

C-1 Attended monthly noise monitoring results – March 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	22/03/2023	57	52	No works heard, traffic dominant source
11 Myall St	30/03/2023	57	63	No works heard, traffic dominant noise source
53 Robert St	22/03/2023	65	58	No works heard, traffic dominant source
17 Minimbah Cl	30/03/2023	43	48	No works heard, traffic dominant source
40 Roberts Cct	30/03/2023	49	50	No works heard, traffic dominant source
12 Sygna Cl	30/03/2023	44	49	No works heard, traffic dominant source
45 Kingsway Avenue	30/03/2023	48	57	No works heard, traffic dominant source
121 Lookout Rd	30/03/2023	66	72	No works heard, traffic dominant source
Yallarwah House	31/03/2023	48	51.5	Dominant source was birds, works in the distance at Cut 4 and southern interchange was around 45-50 dB
Ronald McDonald House	31/03/2023	48	48	Dominant noise source was birds, works 400-800m in the distance. Noise from Multiplex site.

C-2 Attended monhtly noise monitoring results – April 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	26/04/2023	57	57.5	No works heard, traffic dominant source
11 Myall St	26/04/2023	57	54.1	No works heard, traffic dominant source
53 Robert St	26/04/2023	65	57.2	No works heard, traffic dominant source
17 Minimbah Cl	26/04/2023	43	54.6	No works heard, traffic dominant source
40 Roberts Cct	26/04/2023	49	48.9	No works heard, traffic dominant source
12 Sygna Cl	26/04/2023	44	48.2	No works heard, traffic dominant source
45 Kingsway Avenue	26/04/2023	48	48.6	No works heard, traffic dominant source
121 Lookout Rd	26/04/2023	66	76.9	No works heard, traffic dominant source
Yallarwah House	28/04/2023	48	52.2	No works heard, traffic/ Multiplex works dominant source
Ronald McDonald House	28/04/2023	48	46.2	No works heard, birds dominant source

C-3 Attended monhtly noise monitoring results – May 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	31/05/2023	57	57.6	No works heard, traffic dominant source
11 Myall St	31/05/2023	57	55.3	No works heard, traffic dominant source
53 Robert St	31/05/2023	65	57.1	No works heard, traffic dominant source
17 Minimbah Cl	31/05/2023	43	52.7	No works heard, traffic dominant source
40 Roberts Cct	31/05/2023	49	46.5	No works heard, wind dominant source
12 Sygna Cl	31/05/2023	44	53	No works heard, traffic dominant source
45 Kingsway Avenue	31/05/2023	48	44.7	No works heard, traffic dominant source
121 Lookout Rd	31/05/2023	66	71.7	No works heard, traffic dominant source
Yallarwah House	31/05/2023	48	54.5	No works heard, traffic dominant source
Ronald McDonald House	31/05/2023	48	58.2	Works heard – sound levels still under construction activity maximum noise management exceedance for standard construction hours. Noise management controls were discussed and implemented with area supervisor

C-4 Attended monhtly noise monitoring results – June 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	26/06/2023	57	54	No works heard, traffic dominant source
11 Myall St	26/06/2023	57	60.5	No works heard, traffic dominant source
53 Robert St	27/06/2023	65	59.3	No works heard, traffic dominant source
17 Minimbah Cl	26/06/2023	43	56.1	No works heard, traffic dominant source
40 Roberts Cct	27/06/2023	49	52	No works heard, traffic dominant source
12 Sygna Cl	26/06/2023	44	47.4	No works heard, traffic dominant source
45 Kingsway Avenue	26/06/2023	48	54.9	No works heard, traffic dominant source
121 Lookout Rd	26/06/2023	66	70.6	No works heard, traffic dominant source
Yallarwah House	29/06/2023	48	48.9	No works heard, traffic dominant source
Ronald McDonald House	30/06/2023	48	57.8	No works heard, birds dominant source

C-5 Attended monhtly noise monitoring results – July 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	25/07/2023	57	53.8	No works heard, traffic & birds dominant source
11 Myall St	25/07/2023	57	57.6	Some works heard, traffic and birds background. Work source contribution calculated to be 51.2 dB.
53 Robert St	25/07/2023	65	60.8	Piling works heard intermittently. Traffic and birds prominent background noise. Piling works contribution calculated to be 57.7 dB.
17 Minimbah Cl	18/07/2023	43	59.5	No works heard, traffic & birds dominant source
40 Roberts Cct	25/07/2023	49	47.6	No works heard, birds dominant source
12 Sygna Cl	18/07/2023	44	51.4	No works heard, birds dominant source
45 Kingsway Avenue	18/07/2023	48	47.5	Some mainline works heard. Contribution calculated to be 44 dB. Correction = -5.7 dB.
121 Lookout Rd	25/07/2023	66	72.3	No works heard, traffic dominant source
Yallarwah House	25/07/2023	48	47.5	No works heard, birds dominant source
Ronald McDonald House	25/07/2023	48	51.5	Some works heard through bush intermittently. Construction noise contribution calculated to be 51 dB. Sound levels still under construction activity maximum noise management exceedance for standard construction hours

C-6 Attended monhtly noise monitoring results – August 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	23/08/2023	57	52.9	No works heard, traffic dominant source
11 Myall St	23/08/2023	57	58.6	Structures works heard, crane operating. FH contribution determined to be 55 dB when adjusted for duration.
53 Robert St	23/08/2023	65	59.7	No works heard, traffic dominant source
17 Minimbah Cl	23/08/2023	43	46	No works heard, birds & traffic dominant source
40 Roberts Cct	23/08/2023	49	51.3	No works heard, birds & wind dominant source
12 Sygna Cl	23/08/2023	44	43.3	No works heard, birds, wind & traffic dominant source
45 Kingsway Avenue	23/08/2023	48	50.4	No works heard, birds dominant source
121 Lookout Rd	23/08/2023	66	70.2	No works heard, traffic dominant source
Yallarwah House	24/08/2023	48	50.7	No works heard, birds dominant source. Some Multiplex works heard.
Ronald McDonald House	24/08/2023	48	54.4	Some dozer works heard. Dominant noise source was dozer & birds. Sound levels measured are under construction activity maximum predicted noise management level exceedances for standard construction hours for the construction activity (earthworks) undertaken in NCA14 (Table 15 & Table 17, NVMP). In accordance with Table 16 in the NVMP Laeq(15min) <10 dB(A) above NML does not require any additional mitigation measures to NML mitigation levels.

C-7 Attended monhtly noise monitoring results – September 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	21/09/2023	57	54.9	No works heard, traffic & wind dominant source
11 Myall St	22/09/2023	57	57.8	Some works heard. Dominant source was wind. FH contribution determined to be 48 dB when adjusted for duration.
53 Robert St	22/09/2023	65	59.3	No works heard, traffic dominant source
17 Minimbah Cl	18/09/2023	43	49	No works heard, traffic dominant source
40 Roberts Cct	18/09/2023	49	48.9	Some earthworks heard in distance. Wind and birds dominant source
12 Sygna Cl	18/09/2023	44	43.5	No works heard, birds dominant source
45 Kingsway Avenue	18/09/2023	48	50.6	No works heard, traffic & birds dominant source
121 Lookout Rd	22/09/2023	66	70.8	No works heard, traffic dominant source
Yallarwah House	22/09/2023	48	54.7	No works heard, birds dominant source
Ronald McDonald House	22/09/2023	48	53.3	Birds dominant source. Some works heard far way, quieter than the birds.

C-8 Attended monhtly noise monitoring results – October 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	24/10/2023	57	59.9	No works heard, traffic dominant source
11 Myall St	25/10/2023	57	56.1	No works heard, wind& traffic dominant source
53 Robert St	24/10/2023	65	57	No works heard, birds dominant source
17 Minimbah Cl	24/10/2023	43	52.4	No works heard, birds dominant source
40 Roberts Cct	23/10/2023	49	49.7	No works heard, wind/trees dominant source
12 Sygna Cl	23/10/2023	44	56.8	No works heard. Helicopter significant noise source
45 Kingsway Avenue	23/10/2023	48	47.1	No works heard, birds dominant source
121 Lookout Rd	25/10/2023	66	70.1	No works heard, traffic dominant source
Yallarwah House	25/10/2023	48	53.2	Wind & birds dominant source. Multiplex works heard in background
Ronald McDonald House	30/10/2023	48	52.2	Works heard – L_{aeq} within allowable limits for construction noise at this NCA

C-9 Attended monhtly noise monitoring results – November 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	24/11/2023	57	58.7	No works heard, traffic dominant source
11 Myall St	24/11/2023	57	59.8	No works heard, traffic dominant source
53 Robert St	24/11/2023	65	58.4	No works heard, wind & traffic dominant source
17 Minimbah Cl	24/11/2023	43	52.8	No works heard, birds dominant source
40 Roberts Cct	24/11/2023	49	50.3	No works heard, traffic and birds dominant source
12 Sygna Cl	24/11/2023	44	51.8	No works heard, birds dominant source
45 Kingsway Avenue	24/11/2023	48	46.9	No works heard, birds dominant source
121 Lookout Rd	24/11/2023	66	70.8	No works heard, traffic dominant source
Yallarwah House	27/11/2023	48	47.2	No works heard, birds dominant source
Ronald McDonald House	27/11/2023	48	49.6	Some works heard – FH contribution determined to be 44 dB when adjusted for duration

C-10 Attended monhtly noise monitoring results – December 2023

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	18/12/2023	57	54.3	No works heard. Traffic & birds dominant source
11 Myall St	18/12/2023	57	61.9	No works heard, birds dominant source
53 Robert St	18/12/2023	65	58.4	No works heard, traffic and birds dominant source
17 Minimbah Cl	18/12/2023	43	53.2	No works heard, birds dominant source
40 Roberts Cct	18/12/2023	49	49.1	No works heard, crickets dominant source
12 Sygna Cl	18/12/2023	44	60.4	No works heard, crickets dominant source
45 Kingsway Avenue	18/12/2023	48	59.4	No works heard, crickets dominant source
121 Lookout Rd	15/12/2023	66	69.8	No works heard, traffic dominant source
Yallarwah House	18/12/2023	48	52.8	Yallarwah footpath works being undertaken. Roller and vibe plate within 30m of monitoring location. Sound levels measured are under construction activity maximum predicted noise management level exceedances for standard construction hours for the construction activity (earthworks) undertaken in NCA14 (Table 15 & Table 17, NVMP). In accordance with Table 16 in the NVMP Laeq(15min) <10 dB(A) above NML does not require any additional mitigation measures to NML mitigation levels.
Ronald McDonald House	18/12/2023	48	59.5	Scraper haul cut 2 to fill 2 – multiple scrapers and dozers within line of sight, approx. 100m away. Sound levels measured are under construction activity maximum predicted noise management level exceedances for standard construction hours for the construction activity (earthworks) undertaken in NCA14 (Table 15 & Table 17, NVMP). In accordance with Table 16 in the NVMP Laeq(15min) <10 dB(A) above NML does not require any additional mitigation measures to NML mitigation levels.

C-11 Attended monhtly noise monitoring results – January 2024

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	23/01/2024	57	52.3	No works heard, traffic dominant source
11 Myall St	23/01/2024	57	64	Dominant noise source was dozer and traffic. Truck and dogs, dozer, posi and scrapers working 200-300m from sensitive receiver. FH contribution determined to be 55 when adjusted for duration.
53 Robert St	23/01/2024	65	59.8	Dominant noise source was traffic and cicadas. Excavator began moving materials approx. 50m away from monitoring point halfway through noise sample.
17 Minimbah Cl	23/01/2024	43	44.8	Dominant noise source was birds and traffic. FH contribution determined to be 34 dB when adjusted for duration.
40 Roberts Cct	23/01/2024	49	49.7	No works heard, birds & wind/trees dominant source
12 Sygna Cl	24/01/2024	44	47.4	Dominant noise source was cicadas. FH contribution determined to be 40 dB when adjusted for duration.
45 Kingsway Avenue	24/01/2024	48	48.4	No works heard, cicadas dominant source
121 Lookout Rd	24/01/2024	66	72.8	Dominant source was traffic. 11:04 – 11:07 – excavator in Cut 1 heard working in background – never dominant source.
Yallarwah House	29/01/2024	48	56.5	No works heard, pressure washer motor dominant source. 3 excavators and a moxie working within 500m as part of JHH works.
Ronald McDonald House	29/01/2024	48	49.4	Multiple plant working approx 200m away. Sound levels measured are under construction activity maximum predicted noise management level exceedances for standard construction hours for the construction activity (earthworks) undertaken in NCA14 (Table 15 & Table 17, NVMP). In accordance with Table 16 in the NVMP Laeq(15min) <10 dB(A) above NML does not require any additional mitigation measures to NML mitigation levels.

C-12 Attended monhtly noise monitoring results – February 2024

Location description	Date	NML	$L(A)_{eq(15min)}$	Comments
4 Crest Rd	22/02/2024	57	51.7	Dominant noise source was traffic. Some construction works heard briefly in background.
11 Myall St	22/02/2024	57	55.5	Dominant noise source was hammering on site.
53 Robert St	22/02/2024	65	52.7	Dominant noise source was traffic. Posi operating within line of sight. Hammering at Bridge 5 audible. Plant operating in Zone 4 briefly heard in background.
17 Minimbah Cl	22/02/2024	43	47.5	Dominant noise source was traffic. Works heard briefly in background – never dominant source.
40 Roberts Cct	22/02/2024	49	43.8	No works heard, wind/trees dominant source
12 Sygna Cl	22/02/2024	44	47.3	Dominant noise source was plant moving on site. FH contribution was 44 dB when adjusted for duration
45 Kingsway Avenue	22/02/2024	48	47.3	No works heard, generator at residents house dominant source
121 Lookout Rd	22/02/2024	66	73.1	No works heard, traffic dominant source
Yallarwah House	22/02/2024	48	49	No FH works heard. Dominant noise source was Multiplex works
Ronald McDonald House	22/02/2024	48	53	Dominant noise source was FH construction works. Dozer, excavator, and trucks working within line of sight, approx. 500m away. Sound levels measured are under construction activity maximum predicted noise management level exceedances for standard construction hours for the construction activity (earthworks) undertaken in NCA14 (Table 15 & Table 17, NVMP). In accordance with Table 16 in the NVMP Laeq(15min) <10 dB(A) above NML does not require any additional mitigation measures to NML mitigation levels.

C-13 Noise monitoring results - OOHW

Location description	Date	Activity	NML	Criteria	$L(A)_{eq(15min)}$	Comments
33 Victory Parade	8/03/2023	EWP delivery via a float	46	46	53	Traffic was the dominant noise source
85 Lookout Rd	8/03/2023	Signage installation hand tools	38	70	61	
53 Robert St	9/03/2023	Clearing using excavator and chainsaw	46	84	59	
193 Newcastle Rd	14/03/2023	Clearing middle of roundabout with excavator	41	83	57.8	Traffic is the dominant noise source from 70m
83 Lookout Rd	15/03/2023	Line marking removal	38	73	65.2	
53 Robert St	21/03/2023	Excavator in slip lane	41	83	73	Traffic is the dominant noise source from 70m
195 Newcastle Rd	21/03/2023	Excavator in slip lane	46	84	70	Traffic is the dominant noise source
193 Newcastle Rd	21/03/2023	Stripping of topsoil for the Jesmond slip lane – south side	41	73	<70	Traffic is the dominant noise source (70-75 dB). Trucks 79-87dB (not construction related)
195 Newcastle Rd	23/03/2023	Stripping topsoil of the slip lane	41	73.7	73.7	
117 Lookout Rd	29/03/2023	Barrier installation	54	77	79.9	Noise from works minimal compared to standard road traffic. Regular breaks in between Franna reversing and placing barriers reducing impacts on receivers.
121 Lookout Rd	30/03/2023	Clearing	38	72	69	Traffic is the dominant noise source
83 Lookout Rd	30/03/2023	Clearing	54	68	65	Traffic is the dominant noise source at approx. 66 dB

Location description	Date	Activity	NML	Criteria	$L(A)_{eq(15min)}$	Comments
Corner of De Guerry Av & Dean Parade	30/03/2023	Clearing	37	49	33	Works approx. 31 dB
Corner of McCaffrey & Marshall St	30/03/2023	Clearing	38	49	61	Traffic was the dominant noise source (64-78 dB). Works 40-45 dB when no traffic.
232 Newcastle Rd	19/04/2023	Asphalting slip lane	46	63	62.2	Traffic was the dominant noise source at 65-70 dB.
195 Newcastle Rd	19/04/2023	Asphalting slip lane	41	71	61.6	Works were not audible, just traffic from Newcastle Rd. Works were 55 dB and only just audible from monitoring location. Traffic dominant
195 Newcastle Rd	1/05/2023	Pinning barriers	41	77	63.1	Traffic was the dominant source at 55-65 dB. Works in breaks of traffic was 50 dB.
234 Newcastle Rd	1/05/2023	Pinning barriers	46	66	56.6	Traffic was the dominant noise source at 55-65 dB. Works in breaks of traffic was 50 dB.
187 Newcastle Rd	15/05/2023	Telstra works	51	60	68	Traffic was the dominant noise source at 63-79 dB. Works were recorded at 62 dB for 45 seconds. Small excavator generating minimal noise when compared to background traffic.
57 Mary St	15/05/2023	Clearing and mulching vegetation	48	67	69	Chipper creating major source of noise. Noise blankets used on fence to dampen spill.
83 Lookout Rd	8/06/2023	Earthworks – loading moxie in cut 1, hauling across McCaffrey Drive to fill 2	54	54	64.6	Works not audible over traffic. Traffic was the dominant noise source between 55-75. A break in traffic was monitored at 50 dB.
335 McCaffrey Drive	8/06/2023	Earthworks – loading moxie in cut 1, hauling across McCaffrey Drive to fill 2	47	46	58	Traffic was the dominant noise source between 60-70 dB. Works were not audible.
35 Kingsway Drive	8/06/2023	Earthworks – loading moxie in cut 1, hauling across McCaffrey Drive to fill 2	35	45	44.7	Minimal works audible, dominant noise source dogs barking at 43 dB

Location description	Date	Activity	NML	Criteria	$L(A)_{eq(15min)}$	Comments
51 Atherton Cl	5/07/2023	Moxy haul	35	44	41.3	No works heard
13 Cambridge Dr	5/07/2023	Moxy haul	35	39	40.5	No works heard
81 Lookout Rd	5/07/2023	Moxy load and haul	38	50	63.8	No works heard
117 Lookout Rd	5/07/2023	Moxy haul – loading moxy	38	43	66.1	No works heard
335 McCaffrey Dr	5/07/2023	Moxy haul	38	46	70	No works heard
232 Newcastle Rd	6/07/2023	Asphalting	46	46	63.2	Some works heard, traffic still dominant source. Works are line of sight approx. 40m.
195 Newcastle Rd	6/07/2023	Asphalting	41	41	53.8	Works barely heard, traffic dominant
195 Newcastle Rd	11/07/2023	Line marking and removal and TCS works on western and northern side of the roundabout	41	57	54	
230 Newcastle Rd	11/07/2023	Line marking and removal and TCS works on western and northern side of the roundabout	46	63	57.4	
162 Michael St	11/07/2023	Line marking and removal	40	53	54.3	Traffic was the dominant noise source up to 63 dB. Break in traffic works were 52 dB.
181 Newcastle Rd	28/08/2023	Vac truck	51	64	70.2	Vac truck during break in traffic 55-60 dB. Traffic dominant noise source up to 93 dB.
58 Victory Parade	28/08/2023	Vac truck	40	41	53.5	Works not heard. Cars passing up to 73 dB.
187 Newcastle Rd	28/08/2023	Vac truck	41	56	60.1	Works heard in break in traffic at 54 dB. Traffic dominant noise source. Truck passing up to 72 dB.

Location description	Date	Activity	NML	Criteria	$L(A)_{eq(15min)}$	Comments
23 Mary St	28/08/2023	Vac truck	35	34	42.1	Works could not be heard, crickets dominant noise
185 Michael St	5/09/2023	NICB NB line marking removal	40	67	55.1	
55 William St	6/09/2023	NICB NB line marking removal	40	66	67	Works heard at 67 dB
10 Coles St	5/10/2023	Saw cutting	46	74	60.1	Some works heard – noise fades as saw goes away from sample location
1 Robinson Avenue	5/10/2023	Saw cutting	46	63	59.7	No works heard
234 Newcastle Rd	25/10/2023	Concrete saw road	56	74	72	Traffic passing at approx. 70 dB. Dominant noise source of consistent saw cutting 66 dB at approx. 20m away
54 Robert St	25/10/2023	Concrete saw cutting	35	66	56	Traffic passing consistently. Break in works 50 dB
147 Michael St	25/10/2023	Demo saw road	35	54	49.1	Saw dominant noise source – consistent noise source just under 50 dB. Child screaming 49 dB.
18 Coles St	25/10/2023	Demo saw	46	79	78	2x demo saws max at 82.5 dB. Traffic 55 dB during break in works.
Cut 1 nightworks	1/11/2023	Cut 1 nightworks	38	65	50.7	Unattended
Fill 1 nightworks	2/11/2023	Fill 1 nightworks	38	65	50.9	Unattended
6 Bond Cl	14/11/2023	Earthworks	40	40	40.2	Crickets dominant source.
Fill 1 nightworks	15/11/2023	Fill 1 nightworks	38	65	56.2	Unattended
Fill 1 nightworks	16/11/2023	Fill 1 nightworks	38	65	53	Unattended
Northern interchange	21/11/2023	Asphalting	41	77	57.1	Unattended
66 Victory Parade	21/11/2023	Asphalting	51	51	51.3	Beeping from the posi truck can be heard faintly. Posi reversing constantly. Can hear traffic over works except for the reversing beeper.

Location description	Date	Activity	NML	Criteria	$L(A)_{eq(15min)}$	Comments
234 Newcastle Rd	21/11/2023	Asphalting	46	46	64.5	Traffic is the dominant noise source ranging from 58-68 dB when paver is not operating. When paver is operating it is the dominant noise source in conjunction with the posi-track
235 Newcastle Rd	21/11/2023	Asphalting	46	46	65.8	Traffic is the dominant noise source ranging from 58-68 dB when paver is not operating. When paver is operating it is the dominant noise source in conjunction with the posi-track
Northern interchange	22/11/2023	Asphalting	41	77	56.7	Unattended
Northern interchange	11/12/2023	Concrete saw	46	68	62	Unattended
Northern interchange	10/01/2024	Slip lane extension	41	77	62	Unattended
Northern interchange	11/01/2024	Slip lane extension	41	77	59.1	Unattended
Northern interchange	15/01/2024	Slip lane	41	77	59	Unattended
121 Lookout Rd	16/02/2024	Concrete pour	38	38	68.2	Traffic still constant, between traffic crickets are still dominant source (52 dBa). Some faint humming from works in Cut 1 but not dominant source. 200m away – not line of sight. Behind earth barrier in the cut.
Lookout Rd car park	16/02/2024	Concrete pour	38	38	65.9	Second monitoring location – dirt car park near cottage compound. Works are line of sight, approx. 250m. Traffic dominant source, no works heard
75 Dangerfield Dr	22/02/2024	Shotcreting	35	35	54.6	Kookaburras dominant source
Zone 1 stockpile area	26/02/2024	Hammering	41	72	67	Noise blankets used, works within line of sight, 50m from sample location
McDonald's grass area	26/02/2024	Hammering	41	82	62	90m from works, not line of sight, blankets still used.

B-14 Noise monitoring results – response to complaint

Location description	Date	NML	Criteria	$L(A)_{eq(15min)}$	Comments
Cut 1 nightworks	1/11/2023	38	65	50.7	Unattended
Fill 1 nightworks	2/11/2023	38	65	50.9	Unattended
6 Bond Cl	14/11/2023	40	40	40.2	Crickets dominant source. FH contribution determined to be 38 when adjusted for duration
Fill 1 nightworks	15/11/2023	38	65	56.2	Unattended
Fill 1 nightworks	16/11/2023	38	65	53	Unattended
66 Victory Parade	21/11/2023	51	51	51.3	Beeping from the Posi truck can be heard faintly. Posi reversing constantly. Can hear traffic over works except for the reversing beeper.
Northern interchange	21/11/2023	41	77	57.1	Unattended
234 Newcastle Rd	21/11/2023	46	77	64.5	Traffic is the dominant noise source ranging from 58-68 dB when paver is not operating. When paver is operating it is the dominant noise source in conjunction with the posi beeper
235 Newcastle Rd	21/11/2023	46	77	65.8	Traffic is the dominant noise source ranging from 58-68 dB when paver is not operating. When paver is operating it is the dominant noise source in conjunction with the posi beeper
Northern interchange	22/11/2023	41	77	56.7	Unattended
Fill 1	24/01/2024	38	65	56.4	Unattended
6 Bond Cl	14/11/2023	40	40	40.2	Crickets dominant source. FH contribution determined to be 38 when adjusted for duration
66 Victory Parade	21/11/2023	51	51	51.3	Beeping from the Posi track can be heard faintly. Posi reversing constantly. Can hear traffic over works except for the reversing beeper.
Fill 1	24/01/2024	38	65	56.4	Unattended

C-14 Noise monitoring results – Spot checks of noise intensive plant

Plant / ID	Date	Distance (m)	Db(A)	Distance (m)	Db(A)	Distance (m)	Db(A)	SWL	75 dBA (m)
Compactor roller 35T 825H	16/01/2024	7	84.5	10	81	16	77.5	109.3	21
Smooth drum roller 20T LE61	16/01/2024	7	71	12	68	16	66	97.2	5
Pad foot roller 20T LE62	16/01/2024	7	72	12	68	16	65	97.2	5
Excavator 52T LE221	16/01/2024	7	71	10	68.5	16	63	95.8	4
Excavator 30T TGE025	16/01/2024	7	68	12	65	16	62	93.3	3
Excavator 23T APH09	16/01/2024	7	68	10	65	16	62	93.3	3
Moxie water cart 40,000L TA400	16/01/2024	2	85	5	78.5	10	72	99.8	7
Water cart 14,000L FVZ193A	16/01/2024	5	82	10	74	13	70	102.1	9

Unattended vibration monitors (SiteHive)

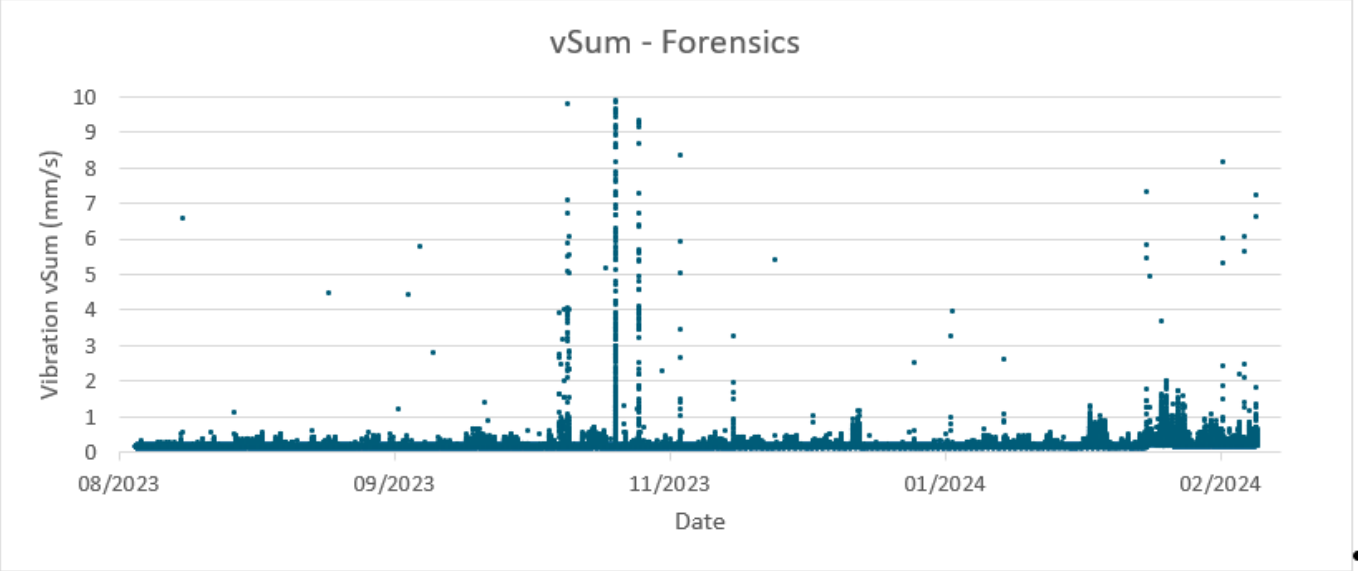

Figure A-11 Forensics fixed vibration monitoring results August 2023 to February 2024

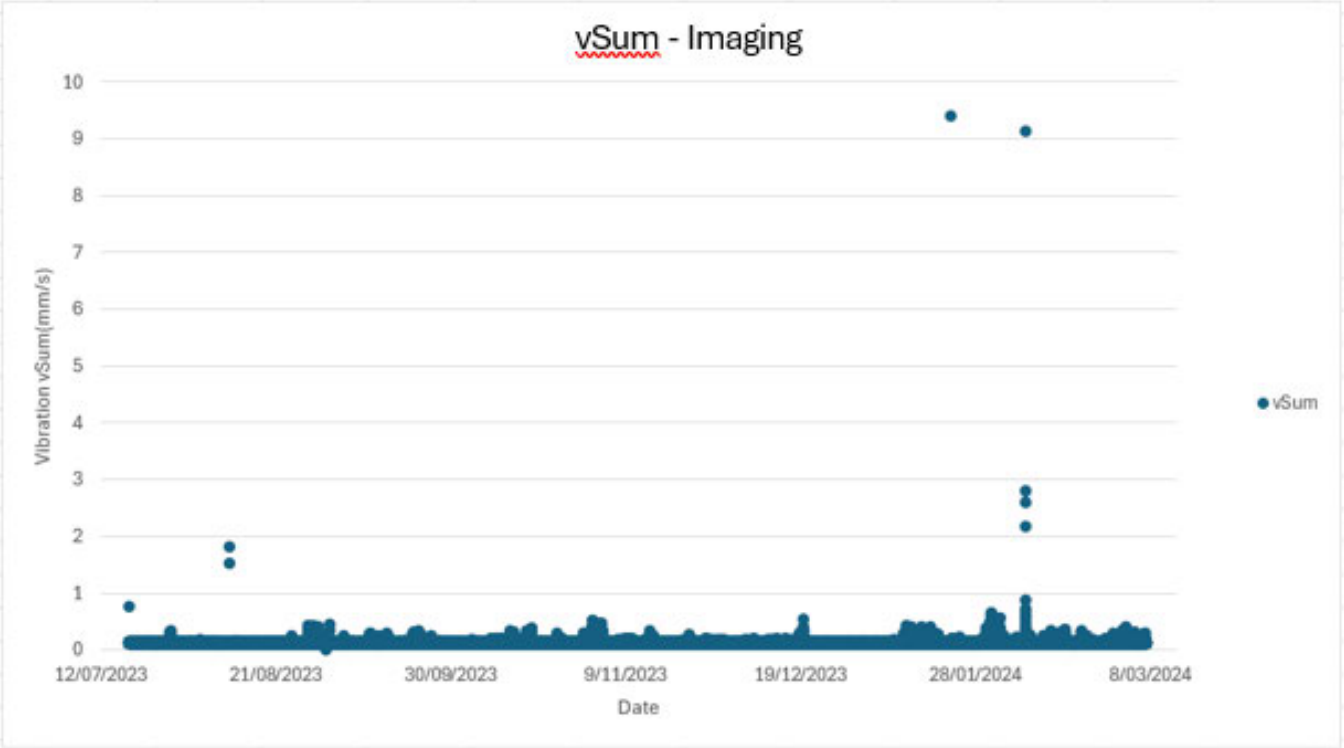

Figure A-13 RSU fixed vibration monitoring results August 2023 to February 2024

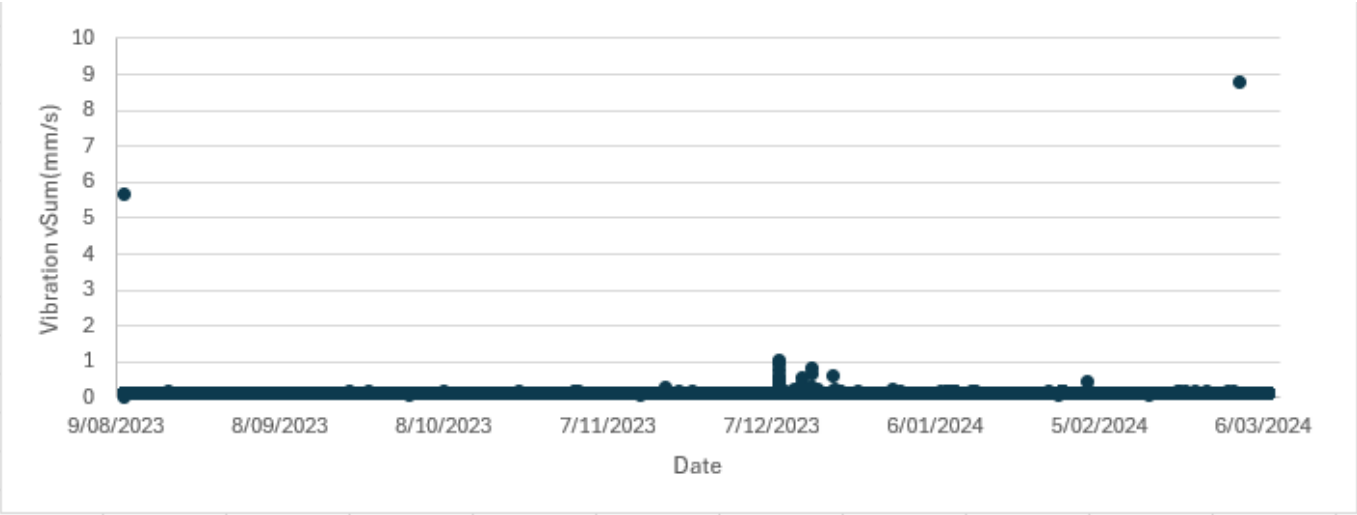

Figure A-11 HMRI fixed vibration monitoring results August 2023 to February 2024

Appendix D Flora and Fauna monitoring program report

Annual Flora and Fauna Monitoring Report

Newcastle Inner City Bypass - RPJ2

NCA23R159750
21 June 2024

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Bright People. Right Solutions.

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Phone: +61 2 4949 5200

21 June 2024
NCA23R159750

Fulton Hogan
Newcastle Inner City Bypass RPJ2
Platt St
Waratah NSW 2298

Attention: Sarah Saunders

Subject: Annual Flora and Fauna Monitoring Report

1 INTRODUCTION

Kleinfelder Australia Pty Ltd (Kleinfelder) has been engaged by Fulton Hogan Construction Pty Ltd (Fulton Hogan) to deliver threatened species ecological monitoring events post vegetation clearance for the Rankin Park to Jesmond Newcastle Inner City Bypass (Project RP2J). These monitoring events are in accordance with the conditions of infrastructure approval SSI6888 and EPBC Conditions of Approval (2015/7550). The Biodiversity Assessment Report (GHD 2018) and Construction Environment Management Plan (CEMP) (Fulton Hogan 2023) outline the direct impacts of vegetation clearance and construction of the Project towards threatened species. The Flora and Fauna Construction Monitoring Program (FFCMP) outlines the methodology for monitoring required for Powerful Owls, the Grey-headed Flying Fox, Threatened Flora species, and replacement habitat features installed in the adjacent vegetation prior to construction commencing. The FFCMP also outlines monitoring requirement for microbat species, this monitoring was undertaken by WSP and the details of that monitoring are separate to this report (WSP 2023).

1.1 PROJECT UPDATE

By July 2023 the majority of clearing was completed, with some minor clearing on McCaffrey Drive still required. Prior to the end of construction additional replacement habitat features are required to be installed in adjacent bushland. There were no unexpected finds during clearing or annual monitoring surveys.

2 METHODS

2.1 POWERFUL OWL MONITORING

Baseline monitoring for the Powerful Owl (*Ninox strenua*) was undertaken by WSP on 11 and 12 July 2022. The baseline monitoring was undertaken at a nest tree (labelled as NT1, **Figure 1**) that was identified to be active during ecological surveys in 2014 (WSP 2022). WSP noted that the condition of the hollowing feature had deteriorated and appeared to be occupied by a Brush-tailed Possum (*Trichosurus vulpecula*). No Powerful Owl activity was observed during the baseline monitoring at NT1.

On 17-19 July 2023, two Kleinfelder ecologists undertook a stag watch[1] of the recorded Powerful Owl nest tree NT1. In accordance with the FFCMP guidelines, surveys occurred 30 minutes prior to sunset and 60 minutes post sunset for three consecutive nights. Sunset occurred at approximately 5.05 PM during this time. If no Powerful Owls were found in the July survey, another survey was required in August. The surveys were undertaken in accordance with the FFCMP and included an inspection of the nest tree to assess the following parameters:

- Presence of breeding pair of Powerful Owls in or near the nest tree
- Breeding pair of Powerful Owls duetting in or near the nest tree
- Presence of juvenile Powerful Owl in or near the nest tree
- Self-relocation of breeding pair of Powerful Owls into another nest tree
- Presence of adult Powerful Owl in or near the nest tree
- Evidence of whitewash, pellets, prey items discarded, or other use surrounding the nest tree.

[1] The stag watch occurred during the Powerful Owl breeding season and in accordance with the monitoring timeframes stipulated in the FFCMP.

The nest tree site was accessed on foot and data was collected by hand-held GPS, photographs, songmeter, and notes in accordance with the FFCMP. Whilst the condition of the hollow had deteriorated, it could not conclusively be disregarded as a potential nest tree, particularly having been utilised by a breeding pair of Powerful Owls previously.

No other potential nest trees were identified outside of the clearing boundary during pre-clearance surveys.

2.2 Threatened Flora Monitoring

On 21-22 September 2023, two Kleinfelder ecologists conducted Flora surveys for *Tetratheca juncea* (six patches) and *Grevillea parviflora subsp. parviflora* (two patches). Each of the 20m x 20m plots were measured by tape measures, marked with wooden pegs and pink flagging tape, and marked on GPS. The flora patches were accessed on foot and data was collected by hand-held GPS, photographs, and notes. Survey methodology was conducted in accordance with the FFCMP and included an inspection of the patches to assess the following parameters:

- Sub-population density at the species patch
- The most northern and southern extent of populations at the species patch
- Population health at the species patch
- Weediness of the area at the species patch
- Population dieback at the species patch.

The data collected from the survey is the first survey undertaken since construction commenced. The survey was to compare the baseline data to understand any impacts of construction on the two threatened flora species. Additionally, the incurrence of exotic species and threatening weeds. If exotic weeds were present, they were recorded.

2.3 Replacement Habitat Monitoring

A Replacement Habitat Strategy (RHS) was prepared in November 2022 (EMM, 2022). The RHS outlines the methods and plans to provide additional hollow resources to mitigate displaced fauna prior to removing habitats within the project area. The RHS outlines the details of the impacted habitat features from the BAR. The RHS focuses on the three threatened species, including Powerful Owl, Squirrel Glider and Little Lorikeet recorded on site in the surveys completed as part of the BAR in 2015.

About 43.7 hectares of clearing is required for the project. This loss includes the removal of 231 hollow bearing trees within Squirrel Glider and Little Lorikeet habitat and 17 potential Powerful Owl roosts. During detailed design, the construction footprint was refined to minimise impacts to native vegetation and hollow-bearing trees. The BAR identified about 320 hollow-bearing trees that would be impacts, due to design refinements the current clearing boundary will impact 231 hollow-bearing trees.

The RHS outline the three types of replacement habitat which may be implemented in the strategy, including salvaged hollows, carved hollows and nest boxes. Majority of the replacement habitat installed prior to construction commencing was carved hollows. No salvaged hollows have been installed to date.

On 25-29 September 2023 two Kleinfelder ecologists conducted Habitat Replacement surveys of the 178 nest boxes and carved hollows installed prior to construction commencing[2]. Monitoring occurred during with nesting season for hollow-dwelling target species, Little Lorikeets (*Glossopsitta pusilla*), Powerful Owls and Squirrel Gliders (*Petaurus norfolcensis*). The survey methodology was conducted in accordance with the FFCMP and included an inspection of each of the habitat replacement features via a pole camera system to assess the following parameters:

- Habitat replacement occupation
- Presence of any Threatened Species
- Presence of any pest species
- Evidence of fauna activity
- Replacement habitat condition

[2] Installation of habitat features (number and type) was determined in accordance with the Newcastle Inner City Bypass Rankin Park to Jesmond Habitat Replacement Strategy (ERM 2022).

- Weather
- Invasive fauna species.

The data collected from the survey is a baseline record to address the occupancy of the carved hollows and nest boxes installed as a requirement of vegetation clearing and hollow bearing trees being removed.

2.4 Grey-headed Flying-fox Camp Monitoring

Noise monitoring is required in proximity to the known Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp when there is work within 300m of the camp and if noise levels exceed the 46 dBA Noise Management Level (NML) by 10dBA LAeq (weighted over a 15 minute timeframe) trigger further monitoring and assessment requirements at the GHFF camp site.

To mitigate the risk of an exceedance, Fulton Hogan completed a noise model using NoiseCheck software to predict the noise impacts at the GHFF camp. Hammering was modelled to be the loudest activity to occur on Lookout Road within the Project Area and the noise model did not exceed the NML+10dBA during standard hours. Modelling results confirmed a maximum exceedance of 5 dBA was possible (Fulton Hogan 2023).

2.5 Unexpected Finds

In accordance with the FFCMP, any unexpected finds that were relevant to the purpose and objectives of the FFCMP, were recorded for further review and discussion.

2.6 Monitoring Limitations

The following limitations of the monitoring program have been identified to have impacted results:

- The Powerful Owl nest NT1 identified in the EIS in 2016 had been damaged. The branch with the hollow had fallen down. Monitoring of the tree was still undertaken however adaptive management will need to be implemented for the next monitoring event.
- Replacement hollow monitoring – not all hollows were able to be monitored due to the height of the hollows being higher than maximum feasible pole height and the camera was unable to inspect some hollows.
- Two little lorikeet nest boxes were destroyed, potentially by Sulphur-crested Cockatoos.
- Black-eyed Susan (*Tetratheca juncea*) monitoring was undertaken earlier in the flowering period than in the baseline monitoring event, therefore the results may not represent peak flowering consistent with baseline monitoring.

3 RESULTS AND DISCUSSION

3.1 Powerful Owl Monitoring Results

The results from the July survey are as follows:

- 17 July 2023 – Start of pre-sunset survey was spent scouting NT1 (**Figure 1**) for whitewashing, pellets, discarded prey items, or Powerful Owl roosting/use. There was no evidence of owls recorded on either side of sunset; however, the nest tree was heavily used by Sulphur-crested Cockatoos (*Cacatua galerita*) and Rainbow Lorikeets (*Trichoglossus moluccanus*).
- 18 July 2023 – NT1 was scouted for Powerful Owl use, resulting in no evidence of use by owls. Weather conditions consisted of lightning and light rain. The 60-minute survey period post sunset resulted in cockatoos, lorikeets, and an unidentified corvid using the nest tree throughout the course of the survey period.
- 19 July 2023 – NT1 was scouted for Powerful Owl use, resulting in no evidence of use by owls. Cockatoos and lorikeets that were using the nest tree previously were quiet. At 5:20pm a male Powerful Owl call was heard (ascertained by the pitch of the call) and the intermittent calls were followed, which was approximately 100m west of the nest tree and near the creek line. The calls stopped and the nest tree was watched for the remaining survey period.

As per the FFCMP, no Powerful Owl presence in the July survey period triggered a second survey in August. The results from the August survey are as follows:

- 21 August 2023 – Start of pre-sunset survey was spent scouting NT1 for whitewashing, pellets, discarded prey items, or Powerful Owl roosting/use, resulting in no evidence of owls. Observations consisted of cockatoos and lorikeets chewing and extending hollows in the nest tree. A songmeter was set in a tree about 10m west of the nest tree to pick up owl calls. At 5:42pm, an adult male Powerful Owl was heard calling, and the call was followed to identify the individual, however, it moved away. Nest tree activity was only used by roosting cockatoos and a crow until survey end.
- 22 August 2023 – Start of pre-sunset survey resulted in no Powerful Owl use in or near NT1, however, cockatoos were still present. At 5:37pm there was a hospital helicopter that flew over site, startling cockatoos that were using the nest tree. There was a male Powerful Owl call, at 5:48pm, followed by an owl silhouette in a neighbouring tree at 32.92380 S, 151.68960 E (Figure 1). The neighbouring tree was spotlighted approximately 6m southwest of the nest tree and an adult Powerful Owl was identified, of unknown sex (**Appendix A**). It could not be ascertained whether this individual was the same owl heard from the previous night.
- 23 August 2023 – Start of pre-sunset survey was uneventful as it was raining, however, cockatoos were still present. At 5:36pm there was a brief, faint male Powerful Owl call. At 6:02pm there was a Boobook Owl calling and flying in and around the nest tree. At 6:04pm there was another brief male Powerful Owl call. No other activity was detected.

3.1.1 Powerful Owl Monitoring Discussion

The Powerful Owl survey at NT1 suggests that the tree was not an active nest site for the 2023 breeding season, instead it appears to be a roost site for Sulphur-crested Cockatoos and / or Rainbow Lorikeets. There was a visual observation of one adult Powerful Owl in close proximity to the nest tree, unknown sex, and calls from a male Powerful Owl throughout four of the six survey nights, suggesting a pair of breeding owls may still be active in the area. They may have moved to another location, or they may be utilising various hollows over different seasons.

Surrounding areas were explored to determine a location of a breeding pair or another nest tree. Future survey efforts may be required to further explore the areas along the creek line where the male owl was heard calling.

3.2 THREATENED FLORA MONITORING RESULTS

Previous pre-vegetation clearance survey efforts had pink and blue flagging pins throughout the patches, providing baseline information for the FFCMP. The survey included quadrats (20m x 20m) measured and marked, at each patch, by a wooden peg and pink flagging tape at each of the four corners. Density and subpopulation extent of the two threatened species were collected at each patch. Density counts were defined as *Tetratheca juncea* being measured in clumps, >30cm away from each other and *Grevillea parviflora subsp. parviflora* is measured in stems. The densities were recorded for each patch (below) and photos of survey efforts are in **Appendix A2**. Exotic species and invasive weed species were not detected in any of the patches.

Table 1 Threatened Flora Monitoring Results

Monitoring Date	Species	Common Name	Monitoring Plot	2023 Population Density	Weed Percentage (Braun-Blanquet cover)	Exotic Species Recorded	Notes
Sep-23	*Tetratheca juncea*	Black-eyed Susan	T1	56 clumps	0	-	Robust sub-population mainly at southern end and at top of the hill.
			T2	6 clumps	0	-	Southern end of the hill had most of the sub-population. None on northern end of hill. Not many in this section and no dieback from clumps seen. Vegetation is predominantly bracken fern and slender pea.
			T3	7 clumps	0	-	No dieback for 6 clumps. Only 1 clump showed dieback.
			T4	11 clumps	0	-	Robust flowering. Southwestern extent 1 clump dieback.
			T5	7 clumps	0	-	Sparse clumps.
			TC	18 clumps	0	-	All flowering, no dieback. Robust, green.
	Grevillea parviflora subsp. parviflora	Small-flower Grevillea	G1	17 stems	0	-	1 dieback in northern end.
			G2	12 stems	0	-	Overall, 2 stems in entire 20x20 plot were dead/dying.

3.2.1 Threatened Flora Monitoring Discussion

The Threatened Flora surveys were undertaken during the flowering period for *Tetratheca juncea*. The survey was triggered as a result of Fulton Hogan workers observing flowering. Preliminary results from the survey indicate that the *Tetratheca juncea* and *Grevillea parviflora subsp. parviflora* subpopulations are starting the season by being robust in flowering with minimal dieback. A comparison to the baseline data is further discussed in **Section 4.2**.

3.3 Replacement Habitat Monitoring Results

There have been 178 habitat replacement features installed, consisting of 142 carved hollows and 36 nest boxes. Out of these 178 habitat replacement features, 160 carved hollows and nest boxes were inspected with 18 of the habitat replacement features (ten nest boxes and eight carved hollows) being too high to inspect or inaccessible[3]. Some of the Squirrel Glider nest boxes were unable to be assessed by the pole camera due to the small entrance combined with a lack of dexterity with the pole camera; as detailed in the full datasheet in **Appendix A - Table A.1**. From the 142 carved hollows and nest boxes inspected, 90 of the carved hollows were occupied by invertebrates such as termites, ants, cockroaches, and arachnid species or had sap pools at the bottom and entrance. Three of the nest boxes and one of the carved hollows were occupied by fauna (presented below in **Table 2**). Two Little Lorikeet nest boxes were destroyed, the damage appears to have been caused by Sulphur-crested Cockatoos (**Figure 9**). The other 67 nest boxes and carved hollows were unoccupied.

There were no invasive fauna species recorded present in the habitat replacement features or in the surrounding areas.

[3] A decision was made by the Project Ecologist and the carved hollow contractor to increase the installation height of some features. This was due to a lack of suitable trees in the installation area, primarily due to the high occurrence of natural hollows as well as tree health limitations.

Table 2. Replacement Habitat Monitoring Results Summary

Tree species	Latitude	Longitude	Nest box (N) or Hollow (H)	Fauna notes
Corymbia maculata	-32.9156	151.6919	N	Boobook owl is using the Powerful Owl nest box.
Eucalyptus piperita	-32.9235	151.6875	N	Evidence of bird scat on the external platform of the entrance of the nest box, although no use in the actual box.
Stringbark sp.	-32.9287	151.6889	H	Unidentified bird with two eggs present in lower hollow.
Corymbia maculata	-32.9262	151.6934	N	Damage to two nest boxes.
Corymbia maculata	-32.9295	151.6884	N	Two Crimson Rosellas were using the Powerful Owl nest box.

It is noted that 70% of the replacement habitat was required to be installed prior to construction in accordance with Scope of Works and Technical Criteria (SWTC). Prior to construction commencing - 84% of the habitat replacements were installed, whereas prior to the end of construction - additional replacement habitat features will be installed. There are 33 replacement habitat features remaining to be installed before the end of construction in accordance with the RHS; salvaged hollows will be utilised where possible.

3.3.1 Replacement Habitat Monitoring Discussion

The data collected for the habitat replacements (nest boxes and carved hollows) installed will provide a baseline for future surveys. Based on the data collected, there is currently minimal succession or usage of the habitat replacements, particularly for the three hollow-dwelling targeted species including Little Lorikeets, Powerful Owls, and Squirrel Gliders. According to the FFCMP, monitoring should coincide with nesting season for these hollow-dwelling targeted species. These three species typically nest in hollows from May to September. As these surveys were conducted at the end of September, it would be expected that the replacement habitat would exhibit some level of use from the breeding season.

Two nestboxes were destroyed, potentially by cockatoos, as shown in Appendix A.

3.4 Grey-headed Flying-fox Monitoring Results

Predicted levels did not exceed the NML by 10dBA LAeq during the annual monitoring period. Monthly noise monitoring was completed each month during the monitoring period on Lookout Road approximately 400m from the GHFF camp and there were no exceedances.

As the trigger for additional surveys was not exceeded, no further monitoring was undertaken for the GHFF.

3.5 Unexpected Finds

No unexpected finds were identified during the annual monitoring period.

4 DATA ANALYSIS

4.1 Powerful Owl data analysis

The data collected from the survey aims to measure the impact of construction on breeding and nesting behaviours of the Powerful Owl pair that were recorded to occupy NT1 during the EIS. The results indicate that there is, at a minimum, one male Powerful Owl in the area, however presence of a breeding pair (as defined in Section 5.2.3.2 of the FFCMP) could not be confirmed. The survey could not conclude the presence of a female by call or by sight, and no two birds duetting could be heard. NT1 was not an active nest site and this may be due to degradation of the hollow. Verification of this, via drone or similar should be considered if practicable, prior to the 2024 survey period.

Without a known nesting site it is difficult to ascertain any impact to breeding Powerful Owls as a result of construction impacts by the Project. Further survey may be required to find an active nest site to gain relevant information.

4.2 THREATENED FLORA DATA ANALYSIS

It is noted that the survey was prompted by Fulton Hogan workers observing plants in flower, during construction works. Peak flowering for *Tetratheca juncea* is September-October whereas the *Grevillea parviflora subsp. parviflora* is August to October. Therefore, the numbers reflect the beginning of the flowering period (21 – 22 September 2023), not in the same flowering period as compared to the baseline data presented in the FFCMP (27 - 28 October 2021). **Table 3** shows a comparison of each of the patches between the baseline data collected in 2021 to this survey in September 2023. It must be noted there was no survey in 2022 to compare data. However, in this 2023 survey, there are significant decreases in three *Tetratheca juncea* patches (T1, T4, T5; Figure 1) and *Grevillea parviflora subsp. parviflora* patch G1. Notably, the control site for *Tetratheca juncea* also showed a significant decrease (-75%), suggesting the cause of the decline could be environmental (e.g. seasonal variation in peak flowering) and not necessarily construction related; *Tetratheca juncea* is difficult to detect when it is not in full flower. No ambient evidence or otherwise, such as observations relating to dust or dieback of other species at the monitoring locations, was recorded.

The results identify a 25% reduction to baseline data, which is delineated as an adaptive management trigger for the surveys in the FFCMP in the instance that the decline is evidently related to the Project, which is not conclusive at this time. Adaptive management is further discussed below in **Section 5.2**.

Table 3. Threatened flora monitoring comparison

Species	Common Name	Monitoring Patch	2021 Baseline Population Density	2023 Population Density	Percentage Change in Density	2021 Weed Percentage (Braun-Blanquet cover)	2023 Weed Percentage (Braun-Blanquet cover)	Change in Weed Percentage
Tetratheca juncea	Black-eyed Susan	T1	115	56 clumps	-51.3%	1	0	-100%
		T2	7	6 clumps	-14.3%	0	0	-
		T3	5	7 clumps	40%	1	0	-100%
		T4	45	11 clumps	-75.6%	0	0	-
		T5	51	7 clumps	-86.3%	0	0	-
		TC	72	18 clumps	-75%	0	0	-
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	G1	28	17 stems	-39.3%	0	0	-
		G2	11	12 stems	9.10%	0	0	-

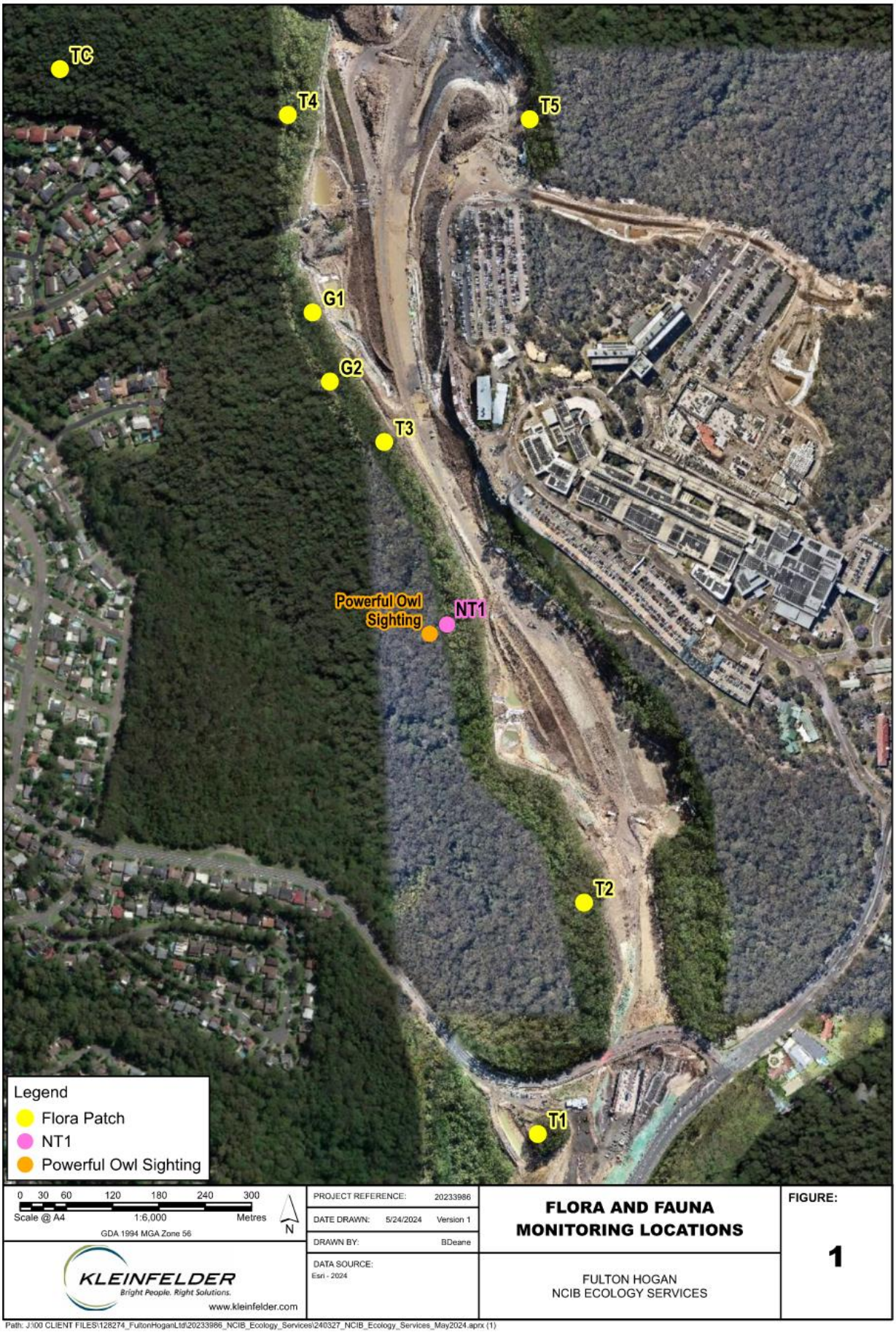

Figure 1 Flora and fauna monitoring locations

4.3 Replacement Habitat Monitoring data analysis

Of the 178 habitat features installed, monitoring identified that only three features were being utilised and the species recorded weren't the threatened species targeted. Monitoring was undertaken within the first year after the installations were completed (approximately nine months), and this may have influenced the results with regards to occupation rate. Further to this, the placement of these features is predominantly outside the project boundary within the surrounding bushland, with some being within the project boundary and in close proximity to the clearing boundary and construction activities. The surrounding tracts of forest hold high levels of naturally occurring hollow bearing trees which allow numerous natural habitat features for existing wildlife.

It is challenging to draw any conclusions on the lower levels of occupation within the given timeframe of the installed features. Threatened species by their very nature can be reclusive and seek out denning and breeding habitat away from development, particularly construction, that involves increased noise and vibration. Habitat replacement monitoring data is provided in **Appendix A - Table A.1**.

5 RECOMMENDATIONS

5.1 Powerful Owl Monitoring

Verification of NT1 as a suitable nest tree should be confirmed if practicable. Further surveys should also be considered early in the 2024 breeding season to detect a breeding pair and locate potential nest trees for future monitoring. Songmeters should be deployed to detect any calls which may help locating Powerful Owls and possible nest trees in the area.

5.2 Threatened Flora Monitoring

The results presented in this report would indicate a decline in population extents for *Tetratheca juncea* across the monitoring sites, and this may be due to environmental factors such as the surveys being conducted outside of the peak flowering period in 2023. It is recommended that future surveys align with the peak flowering period for *Tetratheca juncea*.

5.3 Replacement Habitat Monitoring

It is recommended to continue with monitoring during the breeding period as per the FFCMP, it is likely that more meaningful data will be available at the conclusion of the next monitoring event. It should be noted that there are 33 habitat replacements yet to be installed, these data points will be added as they are available. The monitoring techniques utilised should also be reviewed in an attempt to ensure all habitat features are adequately inspected.

APPENDIX A: HABITAT REPLACEMENT MONITORING RESULTS

Table A.1 Full Replacement Habitat survey spreadsheet

#	x	y	# hollows	Target Species	Nest Box (N) or Hollow (H)	Hollow position in tree(m)	Temperature (*C)	Humidity	Cloudy	Rain	Fauna Activity	Pest Species	Threatened Species	Observation Notes
1	151.6837	-32.9155	2	LL	H	3	24	57	No	No	No	No	No	Sap running from hollows
2	151.6839	-32.9152	1	LL	H	6	24	57	No	No	No	No	No	No notable observations.
3	151.6839	-32.9158	2	SQ	H	4	22	57	No	No	No	No	No	No notable observations.
4	151.684	-32.9158	2	SQ	H	6	24	57	No	No	No	No	No	No notable observations.
5	151.6842	-32.9154	2	LL	H	4	24	57	No	No	No	No	No	Upper hollow is shallow. There is a burnt-out car old right next to the tree.
6	151.6843	-32.9159	2	SQ	H	4	24	57	No	No	No	No	No	No fauna activity in either of the hollows.
7	151.6843	-32.9159	2	SQ	H	5	22	57	No	No	No	No	No	Ants present in upper hollow. Internal decay
8	151.6847	-32.9157	2	SQ	H	3	22	57	No	No	No	No	No	Spiderwebs
9	151.6854	-32.9167	2	SQ	H	4	24	57	No	No	No	No	No	No fauna
10	151.6856	-32.9169	2	SQ	H	4	22	57	No	No	No	No	No	Termite activity in lower hollow. Same tree as #5. 2 hollows.
11	151.6858	-32.9171	2	SQ	H	6	22	57	No	No	No	No	No	No evidence of use in either hollow
12	151.686	-32.9231	2	SQ	H	3	24	71	No	No	No	No	No	Lots of cobwebs
13	151.686	-32.9169	2	SQ	H	5	22	57	No	No	No	No	No	Spider sac in lower hollow. No evidence for faunal use. Sap is leaking from upper hollow on same tree.
14	151.6861	-32.9228	2	SQ	H	7	22	71	No	No	No	No	No	Hollow Covered in cobweb.
15	151.6862	-32.9233	1	LL	H	6			No	No	No	No	No	No notable observations.
16	151.6863	-32.9233	2	LL	H	3	24	71	No	No	No	No	No	No notable observations.
17	151.6864	-32.9168	2	LL	H	6	22	57	No	No	No	No	No	Second hollow in tree 6. No activity, sap coming from the hollow
18	151.6865	-32.9167	2	LL	H	7	20	57	No	No	No	No	No	Cobwebs surrounds lower hollow.
19	151.6866	-32.9249	2	SQ	H	4	15	71	No	No	No	No	No	Rainbow lorikeets surrounding tree. Cockroaches in hollow.
20	151.6867	-32.9231	1	SQ	H	6	22	71	No	No	No	No	No	Lots of spiderweb.
21	151.6869	-32.9248	1	SQ	H	3	15	71	No	No	No	No	No	No notable observations.

#	x	y	# hollows	Target Species	Nest Box (N) or Hollow (H)	Hollow position in tree(m)	Temperature (*C)	Humidity	Cloudy	Rain	Fauna Activity	Pest Species	Threatened Species	Observation Notes
22	151.6869	-32.9167	2	SQ	H	6	22	57	No	No	No	No	No	Both hollows had nothing in them.
23	151.6869	-32.9248	2	SQ	H	5	15	71	No	No	No	No	No	No notable observations.
24	151.687	-32.9235	2	LL	H	4	22	71	No	No	No	No	No	No notable observations.
25	151.6871	-32.9241	2	SQ	H	5	15	71	No	No	No	No	No	Huntsman attacking camera. Down feather of unknown bird species present in lower hollow. No birds present.
26	151.6871	-32.9235	2	LL	H	4	22	57	No	No	No	No	No	2 hollows for LL. Both hollows are about 4 meters high. No use present by any bird or mammal. Only spider egg sacs present.
27	151.6871	-32.924	2	SQ	H	6	15	71	No	No	No	No	No	No notable observations.
28	151.6871	-32.9235	1	LL	H	6	16		No	No	No	No	No	No notable observations.
29	151.6873	-32.9249	1	SQ	H	3			No	No	No	No	No	No notable observations.
30	151.6873	-32.9249	2	SQ	H	5	15		No	No	No	No	No	No notable observations.
31	151.6874	-32.9253	2	SQ	H	6			No	No	No	No	No	No notable observations.
32	151.6875	-32.9253	2	SQ	H	4	14		No	No	No	No	No	No notable observations.
34	151.6876	-32.9241	1	LL	H	4	16	71	No	No	No	No	No	Sap leaking out of this tree. Sap covered the camera
35	151.6876	-32.9241	2	LL	H	6			No	No	No	No	No	No notable observations.
36	151.6876	-32.9247	2	LL	H	0	22	71	No	No	No	No	No	Nothing in the hollow other than a spider egg sac.
37	151.6876	-32.9241	0	-	H	HNR	NA	NA	NA	NA	NA	NA	NA	Trees could not be located. Outside project boundary and unclear if trees have been removed by activities not related to the project.
38	151.6877	-32.924	2	SQ	H	5	16	71	No	No	No	No	No	No notable observations.
39	151.6879	-32.9248	2	SQ	H	5	15	71	No	No	No	No	No	No notable observations.
40	151.688	-32.9247	1	SQ	H	3	15	71	No	No	No	No	No	Spider in hollow with egg sac
41	151.6881	-32.9243	2	LL	H	4	15	71	No	No	No	No	No	Nothing detected
43	151.6889	-32.9287	2	LL	H	HNR	17	88	Yes	Yes	Yes	No	No	Unidentifiable bird, 2 eggs present in lower hollow. 2 hollows. Rainy in AM
44	151.689	-32.9291	2	LL	H	HNR	17	88	Yes	Yes	No	No	No	No fauna activity in either of the hollows.

#	x	y	# hollows	Target Species	Nest Box (N) or Hollow (H)	Hollow position in tree(m)	Temperature (*C)	Humidity	Cloudy	Rain	Fauna Activity	Pest Species	Threatened Species	Observation Notes
45	151.6891	-32.9249	1	PO	N	12	24	71	No	No	No	No	No	Nothing veered out when we were near tree
46	151.6891	-32.9235	2	LL	H	6			No	No	No	No	No	Covered in cobwebs.
48	151.6895	-32.9134	2	SQ	H	5	24	57	No	No	No	No	No	No evidence of fauna use. mud guts.
49	151.6895	-32.9132	2	SQ	H	7	24	57	No	No	No	No	No	No evidence of use. Very empty lower nest box
50	151.6896	-32.9134	1	SQ	H	6	24	57	No	No	No	No	No	Too high to observe with the camera.,
51	151.6896	-32.9134	1	SQ	N	4	24	57	No	No	No	No	No	Cannot access nest box as they do not have holes for access
52	151.6896	-32.9304	2	SQ	H	10	17	88	Yes	Yes	No	No	No	Too high to investigate with camera
53	151.6897	-32.9129	2	SQ	H	HNR	22	57	No	No	No	No	No	Too high to investigate with camera
54	151.6897	-32.9135	2	SQ	H	5	24	57	No	No	No	No	No	No animal usage. No invert usage.
55	151.6899	-32.9134	2	SQ	H	5	22	57	No	No	No	No	No	Only evidence of cockroaches in nest hollow
56	151.6899	-32.9128	2	LL	H	15	22	57	No	No	No	No	No	Too high to inspect.
57	151.6899	-32.9133	2	SQ	H	3	24	57	No	No	No	No	No	No notable observations.
58	151.69	-32.9128	2	LL	H	6	22	57	No	No	No	No	No	No notable observations.
59	151.6901	-32.9129	2	SQ	H	7	22	57	No	No	No	No	No	No notable observations.
60	151.6901	-32.9129	1	SQ	H	5	22	57	No	No	No	No	No	Shallow hollow in upper hollow. Lower hollow, not much activity other than spider eggs
61	151.6905	-32.9126	1	SQ	H	5	22	57	No	No	No	No	No	No notable observations.
63	151.6905	-32.9126	2	SQ	H	7	22	57	No	No	No	No	No	No notable observations.
64	151.6906	-32.9275	3	LL	H	4			No	No	No	No	No	A lot of sap pooled in the 3 hollows
65	151.6907	-32.9279	2	LL	H	6	15	71	No	No	No	No	No	SAP and ants
66	151.6908	-32.9273	1	PO	N	>8	21	88	Yes	No	No	No	No	Unable to tell If there is an occupying animal. Height is greater than 8 m
67	151.6909	-32.9268	2	SQ	H	4	21	88	Yes	No	No	No	No	No notable observations.
68	151.691	-32.9267	2	SQ	H	4	21	88	Yes	No	No	No	No	No fauna. Sap from tree hollow

#	x	y	# hollows	Target Species	Nest Box (N) or Hollow (H)	Hollow position in tree(m)	Temperature (*C)	Humidity	Cloudy	Rain	Fauna Activity	Pest Species	Threatened Species	Observation Notes
69	151.6911	-32.9282	2	LL	H	4	21	88	Yes	No	No	No	No	Cut marks in tree
70	151.6913	-32.9163	2	LL	H	4	22	57	No	No	No	No	No	No notable observations.
71	151.6913	-32.927	2	SQ	H	4	21	88	Yes	No	No	No	No	No fauna activity in either of the hollows.
72	151.6913	-32.927	2	SQ	H	4	21	88	Yes	No	No	No	No	Cobwebs in both hollows
73	151.6913	-32.9274	2	SQ	H	5	21	88	Yes	No	No	No	No	No notable observations.
74	151.6913	-32.9267	2	SQ	H	5	21	88	No	No	No	No	No	No notable observations.
75	151.6913	-32.9162	1	LL	H	6	16	88	Yes	No	No	No	No	Spider egg sac
77	151.6914	-32.9163	1	SQ	H	4	16	88	Yes	No	No	No	No	Spider sac
78	151.6914	-32.928	2	SQ	H	4	21	88	Yes	No	No	No	No	Spiders
79	151.6915	-32.9163	2	SQ	H	6	16	88	Yes	No	No	No	No	No notable observations.
80	151.6915	-32.9271	2	SQ	H	4	21	88	Yes	No	No	No	No	Lots of sap pooling in the hollow
81	151.6915	-32.9269	2	SQ	H	6	21	88	Yes	No	No	No	No	Spider eggs in both hollows
82	151.6916	-32.9147	2	LL	H		17	88	Yes	No	No	No	No	No activity.
83	151.6917	-32.9161	1	LL	H	5	16	88	Yes	No	No	No	No	No notable observations.
84	151.6917	-32.916	2	LL	H	7	17	88	Yes	No	No	No	No	No notable observations.
86	151.6917	-32.9158	2	SQ	H	3	17	88	Yes	No	No	No	No	Cobwebs
87	151.6917	-32.9162	1	LL	H	6	17	88	No	No	No	No	No	Spiders
88	151.6917	-32.9162	2	LL	H	4	17	88	Yes	No	No	No	No	No notable observations.
90	151.692	-32.9146	2	LL	H	HNR	17	88	Yes	No	No	No	No	Spiders in both hollows
91	151.6923	-32.9143	2	LL	H	HNR	17	88	Yes	No	No	No	No	Spiders in both hollows
92	151.6923	-32.9148	2	LL	H	HNR	17	88	Yes	No	No	No	No	Spiders in both hollows
93	151.6924	-32.9145	2	LL	H	HNR	17	88	Yes	No	No	No	No	Upper hollow is shallow. Nothing in hollows.
33	151.6875	-32.9235	1	PO	N	HNR	16	71	No	No	No	No	No	Scat on platform of nest box. No evidence of use within the actual nest box. Some debris on outside entrance.
42	151.6884	-32.9295	1	PO	N	HNR	17	88	Yes	Yes	Yes	No	No	Two crimson rosellas popped out of nest box. Rainy in AM

#	x	y	# hollows	Target Species	Nest Box (N) or Hollow (H)	Hollow position in tree(m)	Temperature (*C)	Humidity	Cloudy	Rain	Fauna Activity	Pest Species	Threatened Species	Observation Notes
47	151.6895	-32.9132	2	LL	N	5	22	57	No	No	No	No	No	The higher nest box was too high to reach with tools available
62	151.6905	-32.9126	1	SQ	N	8	22	57	No	No	No	No	No	2 Nest boxes are too high and have no access point for camera.
76	151.6913	-32.916	2	SQ	N	6	16	88	Yes	No	No	No	No	Nest boxes (2) were unable to be investigated with camera (no access point for camera)
89	151.6919	-32.9156	1	PO	N	9	17	88	Yes	Yes	Yes	No	No	Boobook owl is using the nest box. One individual flew out. Pole wasn't high enough to reach.
94	151.6929	-32.9268	2	SQ	N	4	17	81	No	No	No	No	No	Squirrel glider nest boxes. Inaccessible by pole and camera
96	151.6933	-32.9272	2	SQ	N	3	17	81	No	No	No	No	No	Squirrel glider 2 nest boxes. Unable to access with camera.
98	151.6934	-32.9262	2	LL	N	8	17	81	No	No	No	No	No	No notable observations.
99	151.6934	-32.9262	2	LL	N	6	17	81	No	No	No	No	No	Damaged nest boxes.
100	151.6935	-32.9259	2	LL	N	4	17	81	No	No	No	No	No	Barren nest boxes x 2
101	151.6935	-32.9265	2	LL	N	8	17		No	No	No	No	No	No notable observations.
102	151.6936	-32.9262	2	LL	N	HNR	17	81	No	No	No	No	No	Lower nest box is accessible. Upper nest box is too high
103	151.6936	-32.9265	2	SQ	N	5	17	81	No	No	No	No	No	Squirrel glider nest boxes. Inaccessible by pole
104	151.6936	-32.9259	2	LL	N	6	17	81	No	No	No	No	No	No notable observations.

HNR: Height not recorded

A.2 Powerful Owl Monitoring Photos

Figure 2. Powerful Owl Monitoring Location NT1

Figure 3. Songmeter set up approx. 10m west of the Powerful Owl Nest Tree (NT1)

Figure 4. Powerful Owl, unknown sex, silhouette on August 22nd at 5:48pm

Figure 5. Powerful Owl, unknown sex, silhouette August 22nd at 5:48pm

A.3 Threatened Flora Site Photos

Figure 6. Pre-clearance baseline survey flagging pins (set in 2021).

Figure 7. One of the poles that were set to mark the quadrats in Kleinfelder survey efforts.

Figure 8. Quality of flowers blooming at start of season.

Figure 9. Quality of flowers at T1.

A.4 Replacement Habitat Monitoring Photos and database

Figure 10. Damaged nest boxes

Figure 11. Method to collect data from the habitat replacements

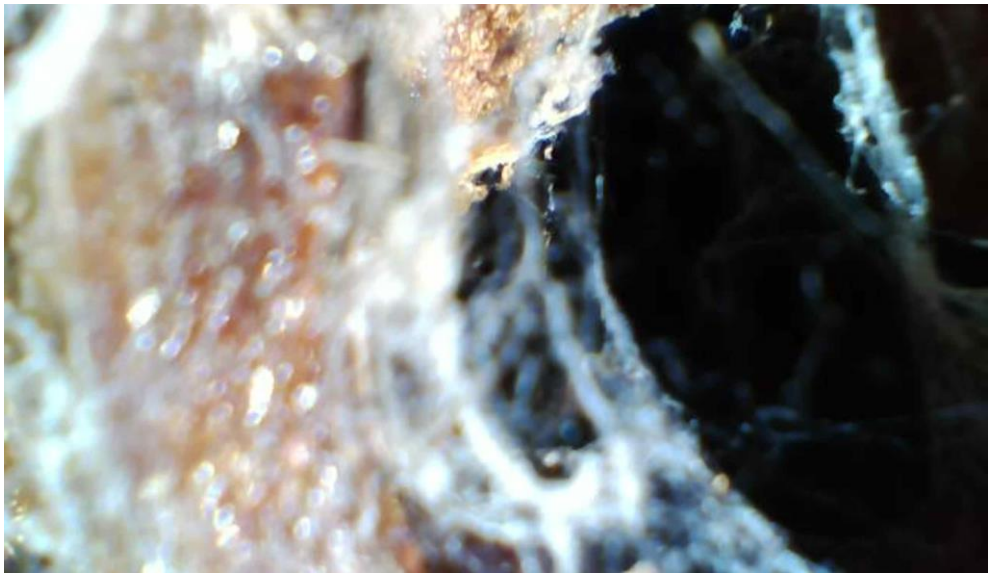

Figure 12. Spider web covering the hollows

Figure 13. Empty Powerful Owl nest box

Figure 14. Crimson Rosella observed to be occupying a nearby Powerful Owl nest box

Figure 15. Boobook Owl observed to be occupying a nearby Powerful Owl nest box

Figure 16. Example of carved hollows